



Loading mail aboard one of TWA's Douglas airliners. (Courtesy of Transcontinental & Western Air, Inc.)

# THE STORY OF FLYING

BY

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"The Story of Tunnels" etc.*

REVISED EDITION

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**THE STORY OF FLYING**

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# Preface

THIS is a narrative record of human flight that makes no pretense of being all-inclusive. So much effort has gone into the development of aircraft that a completely detailed story would entail much repetition of successive efforts to solve the same problem. Hence the author has chosen the course of giving only enough of the high lights to create a mental picture of each period in the development of the balloon, airship and airplane.

Lest the reader be disappointed at the brief space given to daredevil heroes, he is reminded that the story of flying is one of painstaking scientific investigation and experiment. The spectacular flights that have figured so highly in news reports were the result, not the cause, of progress in aviation.

In accordance with time-honored custom, this opportunity is taken to thank for their cooperation the organizations and persons to whom credit is given throughout the book for the use of various illustrations. In most cases the assistance extended beyond the mere furnishing of illustrations and information and included the task of checking parts of the text. Thanks are also extended to the U.S.

## P R E F A C E

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ARCHIBALD BLACK.

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# THE STORY OF FLYING



## Chapter I

# Man Looks to the Sky

### *The Period of Daydreams.*

PICTURE a torrid afternoon ten or twenty thousand years ago—early summer, yet too hot for heavy toil. A soaring bird circles overhead without apparent effort, skirting the shores of a blue sea that men centuries later were to call the Mediterranean. From the shade afforded by some kindly trees a resting Neolithic man watches enviously. In such a way, no doubt, was born man's first futile wish for wings. But many centuries had to pass while the way to realization was being cleared by countless inventions and discoveries. Whole arts had first to be created and then perfected to a high degree before human flight could become even a remote possibility. The entire science of mechanical engineering had to be founded; engines had to be invented and developed. Chemistry had to be born and liquid fuels discovered. Metallurgy had to give us the materials for engines and structures.

Countless centuries of mythology preceded this period of engineering and scientific development—centuries of imaginative legends upon which many

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books have been written. But such daydreams contributed nothing more substantial than hope. And even our casual reference to them is justified only because it serves to show how man looked to the skies through those ages that preceded the first successful balloon, airship and airplane.

### *Legend of Daedalus and Icarus.*

Many of those early legends and daydreams found their way into literature; some of them became classics. Ovid's legend of Daedalus and Icarus, written at almost the beginning of the Christian era, is the most quoted of these flights of fancy. Daedalus, so the legend has it, was an artificer and sculptor of Athens and Crete. He is supposed to have incurred the wrath of Minos, king of Crete, who imprisoned him together with his son Icarus. To escape from this confinement each fashioned for himself a pair of wings, using feathers secured with wax. The pair started across the Aegean Sea and progressed well until Icarus flew so high that the sun melted the wax holding his feathers. Then his wings fell apart and dropped him into the sea. Daedalus, so Ovid has it, completed the voyage successfully—a pretty legend that is destined to be quoted in almost every history of aeronautics. But it makes strange reading today. From a scientist's viewpoint the idea of wings melting because one flew too high is fantastic in the light of modern experience with the cold encountered at high

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altitudes. Had he succeeded in making such a flight, Icarus would more probably have found trouble from ice forming on his wings!

This was not the only legend concerning feathers. Not only the ancients but also the peoples of the Middle Ages attributed magic properties to feathers and almost every legend of early flight refers to the use of feathered wings. As late as the seventeenth century, one experimenter with this type of wing was fortunate enough to land uninjured after his first jump from a roof. Explaining the abrupt end of his experiment, he ruefully insisted that he would have been successful had he used the feathers of an eagle instead of those plucked from an earthbound barnyard hen!

### *Roger Bacon Ruminates on Flight.*

Roger Bacon, English scientist and writer of the thirteenth century, was the first to approach the problem of flying from a scientific angle. Although he never (so far as we know) made any effort to construct models or to carry his speculations beyond the pages of his notebooks, Bacon did show a keen understanding of some aspects of the subject. Conceiving air as a fluid resembling water in its ability to float bodies lighter than itself, he ruminated upon the possibilities offered by this idea. Limited by the knowledge of his time, he speculated that the flying machine would have to be a large hollow globe of

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some extremely thin and light material. Thin sheet copper was his specific suggestion. This container, he wrote, should be filled with what he called "liquid fire" and launched from a high point, whereupon it would float. Thus he left considerable doubt as to whether he had in mind some undiscovered element to which he ascribed miraculous properties or whether he had some concept of the possibilities of hot air—hence anticipating by a few centuries the experiments of the Montgolfiers. Bacon also proposed a flying machine of the flapping-wing type, known today as an "ornithopter," modeled after the principles of bird flight. In this respect he certainly anticipated others. Flapping-wing devices, incidentally, came into popularity among the aeronautically inclined inventors as soon as bird feathers were divested of their magic properties.

But here again mankind was to find itself following a false trail. Several centuries more had to pass before it was realized that birds fly by flapping their wings only at the expense of relatively great muscular effort—effort that, in proportion to the weight lifted, is far beyond the strongest man's capability. Giovanni Borelli, an Italian who died in 1679, concluded from his study of the muscles of birds that man's were greatly inferior. Again, in 1655, this conclusion was propounded by Robert Hooke, an Englishman, who announced that man's muscles were incapable of exerting sufficient energy to enable him to fly like a

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bird. About two and a half centuries later, Octave Chanute estimated that a pigeon the size of a man would exert nearly 3 horsepower. This is something like twenty or thirty times the sustained muscular ability of an average man! Here in a nutshell lies the reason why flapping-wing machines have attained no measure of success up to the present, although very short hops have been claimed for them.

### *The Versatile da Vinci.*

In the fifteenth century some other conceptions of flapping-wing devices originated in the fertile brain of Leonardo da Vinci, the versatile Italian who left his mark in history as a painter, writer, sculptor, architect, engineer and inventor. Da Vinci left many sketchbooks that illustrate the thought that he gave to flying. Some of his flapping-wing schemes would have done credit to the inventors of several generations later. Other sketches showed that he gave consideration also to the helicopter principle, on which is built the type of aircraft that provides direct vertical lift by use of rotating wings. He can even be credited also with the original invention of the parachute. In view of all this investigation, it appears strange that da Vinci never thought of the fixed wing, which subsequently proved to be a solution incorporated in the building of the airplane and the glider. Upon the basis of his numerous sketches, da Vinci is accepted as original inventor of the rotat-

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ing wing as well as of the aerial propeller. Rather strangely, by the way, the first successful application of the propeller principle was in connection with ships. Its application to the airship and airplane came later. Da Vinci apparently built model helicopters that flew more or less successfully and these results emboldened him to go so far as sketching a man-carrying craft to be constructed of bamboo and fabric, with its wings about 96 feet in diameter. There is no record of his having carried this concept further and the probability is that he realized that he had no source of power available with which to equip his craft.

### *De Lana's Vacuum Balloon.*

In the seventeenth century Francesco de Lana invented the vacuum balloon, first proposed rather uncertainly by Roger Bacon. De Lana was both more specific and more scientific than Bacon had been. Hence he deserves credit as the real inventor of the balloon principle, for his language leaves no doubt of his clear understanding of the principles involved. His conception was of a wicker basket that would be lifted into the air by four spherical balloons—although he did not call them by that name. He went to considerable pains to determine the exact weight of air in order to calculate the lifting capacity required. In connection with his experiments to determine the weight of air, he used heat to expand

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the air in a vessel and thus drive out as much as possible of it. If we look back upon de Lana's experiments, it now seems remarkable that he did not stumble upon the solution—the use of hot air—that a century or so later was to result in the first successful balloon. However, the flotation value of hot air apparently escaped him, for de Lana persisted in following the original concept of a vacuum and he worked out the sizes of spheres necessary to give the desired lifting effort. Like Bacon, he proposed to build his spheres of thin copper. Also like Bacon, he failed to realize the magnitude of the external pressure, which would instantly collapse even much heavier shells.

### *A Prophetic Vision of Aerial Warfare.*

De Lana did not follow up his experiments by trying to construct his invention for an amazing reason: he had become alarmed at the possible consequences that might follow its perfection. In his writings he envisioned the use of his floating spheres in warfare for the destruction of cities, ships and men by the dropping of incendiary balls of fire from the skies! Thus, although his invention of a vacuum balloon was destined to failure, de Lana stands out as the original prophet of aerial warfare. And, with nothing more substantial than conceptions such as those of Bacon, da Vinci and de Lana, the history of flying approached the end of the seventeenth century.

## Chapter II

# The Balloon Is Born

### *Hydrogen Is Discovered.*

INVENTORS were still struggling with impossible dreams of floating in the air in vacuum balloons and of flying with impossible contraptions of flapping wings when, in 1766, an English scientist, Henry Cavendish, made a discovery that was destined to be of tremendous importance to flight efforts some years later. This discovery came about when he poured sulphuric acid on pieces of iron, zinc and tin, forming a new gas that possessed unusual characteristics. Cavendish had discovered the element hydrogen. When his new gas was studied it was found to be extremely light and it still remains the lightest element yet discovered. Joseph Black, a Scottish college professor, learned of the discovery and, hearing of the lightness of the element, suggested that some of it be put into bladders to see if they would float in the air. For some inexplicable reason apparently no one tried this at the time. Even Black himself, it seems, failed to take advantage of such opportunity as he might have had, for history records nothing as having come of the suggestion at the time.

## THE BALLOON IS BORN

In 1781, Tiberius Cavallo, an Italian who was then living in England and who had heard of Black's lectures, filled a pig's bladder with hydrogen to see if it would really float in air. The bladder, however, proved to be too heavy and he found no material light enough, although he did succeed in making tiny balloons of soap bubbles after gums, varnishes and similar materials had failed. Apparently discouraged by the difficulty of finding anything strong enough to hold the gas and yet light enough to float, he did nothing further and it remained for others to build the first successful balloon. Strangely enough, this first balloon used simply hot air!

### *The Balloon Is Born.*

The first real accomplishment in human flight came in 1782-1783 at the hands of Joseph and Étienne Montgolfier in France. Joseph had already built the first parachute, which he tested in 1779 by dropping it from a tower with a basket attached in which he had placed a sheep. The two brothers had noticed that smoke always tended to rise and they began to wonder if confining it in a bag would cause the bag to rise. Deciding to find out for themselves, they constructed a bag of silk, which they left open at the bottom. In this opening they burned paper, whereupon the bag became inflated and floated in the air. From this experiment they went on to make larger balloons and their success was so immediate

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that they quickly became famous. The hot-air balloons were named "montgolfiers" after their inventors, the name "balloon" being first applied to Professor Charles' hydrogen balloons. At first everyone believed that the montgolfiers were inflated with a newly discovered gas and some years passed before it was realized that in air expanded by heat lay the secret of their flotation. In addition to making the first successful balloon, the Montgolfiers also established a precedent in "teamwork" by two brothers, a fashion that has been extended through the years in aeronautical experiments. Their first large experimental balloon broke away prematurely, but it floated about a mile before landing, sailing along at heights that reached as much as 1,000 feet. Pleased with this success, the brothers built a large balloon for public demonstration, giving their first exhibition on June 5, 1783, when the balloon went up to about 6,000 feet and floated about 2 miles. At last man had found a means of floating in the air, even though he still had to find some means of controlling his flight.

### *The First Passengers.*

The Montgolfiers made many balloon demonstrations after this. As their first passengers they sent up a duck, a rooster and a sheep. Gaining confidence, they began to send up balloons carrying human passengers, the first man-carrying ascension being

## THE BALLOON IS BORN

made by de Rozier in 1783. With hot-air balloons actually being flown, it was only natural that some one should revive Black's idea of using hydrogen. To Professor J. A. C. Charles fell the honor of constructing the first successful hydrogen balloon—only, however, after considerable difficulty had been encountered in generating the gas in sufficient quantity and in constructing a container that would retain it yet still be light enough to float. A solution of rubber painted on light fabric provided the answer and the first and last ascent was made on August 27, 1783. This passengerless flight was in itself a complete success, but the balloon landed near some ignorant French peasants who became convinced that it was a frightful creature. The more courageous of them savagely attacked it with their pitchforks and soon reduced the hapless gasbag to a complete ruin.

### *An Era of Ballooning.*

Ballooning now became a quite common occurrence, following the demonstrations of the Montgolfiers and Professor Charles. Many notable flights were made and much public interest was aroused. An event of outstanding historic importance was the first aerial crossing of the English Channel, accomplished on January 7, 1785 by Jean Pierre Blanchard, a Frenchman, and Dr. John Jeffries, a Boston physician. The first use of a balloon in warfare

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was for observation made by the French at the battle of Fleurus in 1794, although its first large-scale military use was not made until the Civil War in the United States in 1861. The development of the balloon did not in the least discourage those attacking the problem of flight from the angle of mechanical devices as opposed to flotation. Indeed, the balloon flights seemed merely to spur them on. Furthermore, as the novelty of ballooning wore off it became increasingly evident that its success was greatly impaired by the lack of some means of propulsion to make the balloonist independent of air currents. For the free balloon is almost entirely at the mercy of the winds. The aeronaut's only choice of direction lies in raising or lowering his altitude in the hope of finding a wind moving in the desired direction. This change of altitude is made by dropping sand or water ballast to raise the balloon and by releasing gas to lower it. Many extravagant schemes were advanced by crackbrained inventors in their efforts to provide propulsion for balloons. We find among early records a succession of plans such as those for providing the gasbags with sails—in utter disregard of the fact that the balloon itself floats in and with the air. Sails would add nothing more than useless weight. Other schemes proposed such suggestions as that oars and flaps be operated by man power.

## THE BALLOON IS BORN

### *Cayley Blazes a New Trail.*

During the period of balloon enthusiasm, scientific thought was brought to bear upon the subject of mechanical flight and in the next hundred years tremendous progress was made that paved the way for ultimate solution of this problem. Sir George Cayley, an English scientist, left an indelible mark upon aeronautical history in this period. Cayley began his experiments about 1796 and his interest apparently continued until his death in 1857. His first attempts were with model helicopters. From these he went on to work on gliders and, in 1816, dirigible balloons or (as they are now called) airships. He was probably the first to appreciate the necessity of streamlining, although he did not know it by that name, and he was evidently the first to conceive of the desirability of a structure within the flexible envelope of a balloon. Thus originated the first step toward the invention of the rigid airship, which was to be developed many years later. One of Cayley's most serious difficulties lay in the absence of a suitable engine for propelling his gasbags. Since the steam engine had been invented and was then coming into use in England, Cayley eagerly investigated this promising source—only to find out that in that stage of its development its weight made it out of the question. During this period of scientific activity, the first successful parachute descent by man was made when André-Jacques Garnerin,

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on October 22, 1797, dropped from a balloon at a height of about 6,000 feet and landed safely.

### *Henson's "Ariel."*

In the midst of various freakish ideas for navigation of the air there began to appear a few conceptions that pointed the way toward the device that ultimately, at the hands of the Wrights, was to prove the solution of mechanical flight. A device that he named the "Ariel" was invented by William S. Henson in England between 1840 and 1842 and patented by him in the latter year. Although naturally crude in both its appearance and its projected construction, Henson's "Ariel" embodied most of the essentials of and bore a startling resemblance to the successful monoplanes of many years later. Indeed, Henson's chief omission was the lack of provision for lateral control; his chief errors were his lack of correct proportion and his use of flat instead of curved wing surfaces. Each mistake was natural and excusable in view of the general lack of information on aerodynamics in his day. Henson planned to use a steam engine, a choice from which he had no alternative, since the internal-combustion engine had not then been developed and steam was apparently the only promising source of power. In general arrangement, Henson used a monoplane wing externally trussed like, let us say, Latham's Antoinette of 1909. He provided an enclosed cabin with rear outriggers to



FIG. 1.—A few of the big Douglas airliners that form the Great Silver Fleet of Eastern Air Lines. -



FIG. 2.—Eternal vigilance makes possible the amazing safety record of modern airlines. (Courtesy of Transcontinental & Western Air, Inc.)

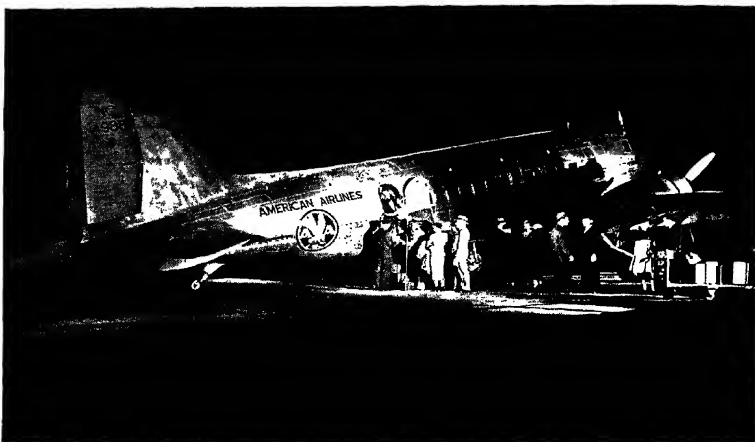


FIG. 3.—The brilliant glare of airport floodlights creates a dramatic setting as passengers embark for a night trip. (*Courtesy of American Airlines, Inc.*)

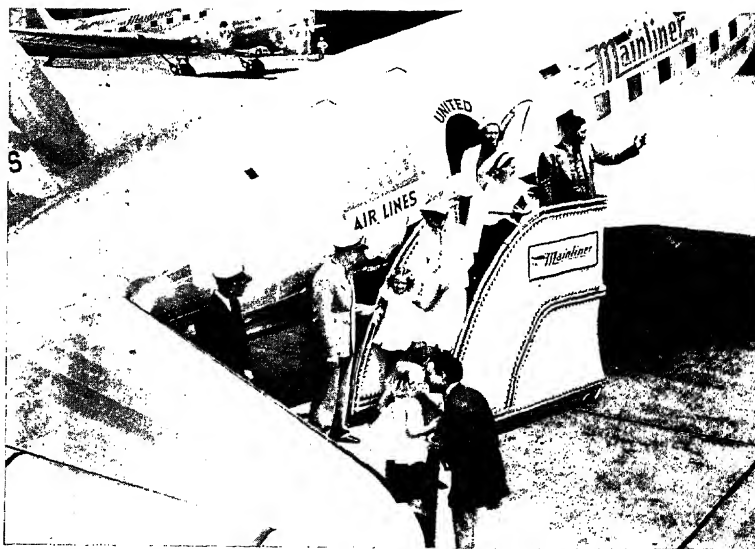


FIG. 4.—Passengers debarking from a Mainliner of United Air Lines.  
(*Photograph by Grignon.*)

## THE BALLOON IS BORN

carry the tail surfaces. Two pusher propellers were placed at about the trailing edge of the wing. Henson had great expectations for his invention and he organized a company with the ambitious plan of operating regular aerial services for carriage of passengers. This was to be the Aerial Transit Company. Perhaps it is just as well that Henson's craft never was able to get into the air. For, although he did have *most* of the essentials, he certainly lacked an adequate system of control. Furthermore, the world had yet so much to learn about aerodynamic loads on wings that Henson had no information upon which to base the design of a practical and safe wing structure. It took many years of laboratory experiment to furnish this knowledge and much of the eventual success of the Wrights was due directly to their thorough investigation of air forces on wings. As it was, Henson encountered so much ridicule that he finally abandoned work on his invention and thus ended his efforts.

### *Stringfellow's Models Fly!*

When Henson gave up his activities on aircraft, his partner, John Stringfellow, continued development of a little steam engine upon which the two had been working. He finally produced a very successful power unit and he continued to experiment with steam-powered models until, in 1848, he succeeded in effecting the first true power flight of a model

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airplane. This flight was of short duration and distance—only about 66 feet—but it covered the full length of the room in which it was tried. The model was about 10 feet in span and the wing chord about 2 feet. Two propellers were used; the complete model weighed about 8 pounds and it was driven by a tiny steam engine. Apparently discouraged by the limited interest shown in his models, Stringfellow abandoned his aeronautical activities for an extended period thereafter. He finally died in 1883 without having had the satisfaction of knowing how near the world had come to true power flight. Before his death Stringfellow had resumed his work, but nothing transpired that equalled in importance his earlier work with models. More or less contemporaneously with Stringfellow, although in no way connected with his work, there came another happening of historic but little other interest. This was the construction of the first metal balloon. It was built in Paris in 1843 of thin sheet brass, but it was too heavy to be lifted from the ground by its own buoyancy.

### *First Successful Airship.*

As already mentioned, many attempts were made to provide balloons with a means of propulsion. But it was September 24, 1852, before a dirigible balloon was flown and its worth proved. This balloon was the creation of Henri Giffard, a French engineer, who designed, built and also flew his elongated gas-

## THE BALLOON IS BORN

bag, from which was suspended a car containing the pilot and a steam engine. In principle his balloon followed the design that had been proposed earlier by Cayley but that could not then be realized for want of a light engine. Giffard's engine, completed in 1851, developed only about 3 horsepower and weighed around 350 pounds. Although it would now be considered enormously heavy for its small power, it represented a remarkable achievement for its time.

### *The First Rigid Airship.*

From time to time in the progress of balloon and airship development the idea of metal had persistently recurred. The first all-metal balloon actually to leave the ground was constructed in Germany by David Schwarz and it was, at the same time, the first *rigid* airship built. Schwarz did not live to finish the construction, but his wife carried it through to completion and a flight was made in 1897. This craft was, for its time, a well-engineered structure of sheet aluminum, about 157 feet long and 46 by 39 feet in its elliptical cross section. Altogether, it established many precedents. With its capacity of 130,500 cubic feet it became the largest airship to that date. Then, of course, it was the first all-metal balloon and at the same time the first rigid airship. Last, but by no means least, it was the first airship to use a gasoline engine. This fact becomes of special significance if it is considered that little of the subsequent progress

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would have been possible without the gasoline engine. Schwarz's power unit consisted of a Daimler 12-horsepower, four-cylinder gasoline engine and it evidently functioned quite well. His metal envelope was riveted together and apparently was not sufficiently gas-tight for the purpose, although the reports indicated that his chief trouble was in devising some means of filling it. Since the metal hull could not be flattened out and then inflated like a fabric balloon, this problem was really serious. On its first and only flight the airship apparently started out quite well but reports differ as to its landing. One version has it that the gas leaked through the seams so rapidly than the pilot was forced to come down. Another source claims that the driving belts came off their pulleys, leaving the pilot with no means of control and forcing him to land. Both reports agree that the airship was badly damaged in landing, although the pilot escaped unhurt, and one report added that curious sight-seers who removed much of the material put the finishing touches to the work of the wind. Thus ended the first and last flight of an outstanding effort in the lighter-than-air branch of flight.

## Chapter III

# Zeppelin and the Modern Airship

### *The Creation of the Rigid Airship.*

COUNT FERDINAND VON ZEPPELIN is always—and rightly so—given full credit for the development of the rigid airship, although it is not generally known that neither he nor Schwarz (whose all-metal airship we described) were actually the original inventors of the rigid type. First to conceive the basic idea was a French engineer named Joseph Spiess, who patented the basic elements in 1873 but apparently contributed little else to its creation. Zeppelin, who was born at Constance in 1838, served as a volunteer in the Union Army during the Civil War in the United States and it has been said that his original idea of a rigid airship came to him while he was assigned to an observation balloon at this time. After the war he returned to Germany and later began work on the idea, but he did not complete his first design plans until about 1894, by which time he had already reached the age of fifty-six. So many of the contributions to aeronautical progress have come from the minds of the younger men that one finds it slightly

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difficult to appreciate the fact that all Zeppelin's work took place in his later years. His rigid airship plans did not meet with enthusiasm on the part of the military authorities or the scientific world and at first he found great difficulty in having his proposals taken seriously. However, in 1898 he really started construction of his first airship. This he completed and successfully flew, but in July of 1900 it was dismantled because of dissatisfaction with its performance. For one thing, its speed was too low—only about  $17\frac{1}{2}$  miles an hour. From the viewpoint of history the important fact is that it flew successfully and demonstrated its controllability.

### *Undaunted by a Succession of Defeats.*

Later Zeppelin obtained the backing of the king of Württemberg and with his and other support he completed the second Zeppelin, which made many thoroughly successful flights but was finally destroyed by storm. Undaunted by this loss, he built a third airship, incorporating improvements suggested by the experience with his first two and in October, 1907, this ship made a flight of 8 hours, covering a distance of about 218 miles. The German federal government now began to take notice and after this flight agreed to purchase a Zeppelin (as the craft were already being called) if its builders could demonstrate its ability to stay up for 24 hours. This new craft followed as the LZ-4 and in July, 1908, Zeppelin flew it over

## ZEPPELIN AND THE MODERN AIRSHIP

the Alps to Lucerne and back to his plant at Friedrichshafen. In the following month he made another equally successful flight after which a windstorm tore the ship loose from its moorings and it caught fire after striking a tree. This new disaster left Zeppelin virtually bankrupt, with all his credit apparently exhausted—"apparently" being precisely the word in this case. For, as chance would have it, the fate of Zeppelin's latest airship had stirred the nation to admiration at the persistence of the man who had been so dogged by a succession of disasters. A popular subscription was started to show the determined old man—already seventy—that his country was behind him in his work. The response to the call was dramatic; within a few weeks the inventor was handed \$1,500,000, which had come spontaneously from the pockets of rich and poor alike. Zeppelin was given carte blanche to go ahead with the development. Touched by this substantial tribute, he no longer regarded his experiments as his own enterprise; they now represented a task assigned to him by the German people and, with this idea, he created the Zeppelin Endowment to carry on his work.

### *The "DELAG" Operations.*

Other Zeppelins followed and by 1910 commercial transport routes were being attempted with the ships. Indeed, if its plans had not been interrupted by the

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First World War, the Zeppelin Company might now be operating routes all over the globe and it is impossible to estimate how far-reaching an effect such an enterprise might have had upon the airplane development that took place some years later. At present, transportation by airship is at the lowest ebb in many years, its place seemingly having been taken by airplanes, which offer more rapid service over the same routes. It is quite often forgotten today that the first regular transport routes in the world were those operated with Zeppelins in Germany as early as 1910-1911 and continued up to the outbreak of war. The service was operated by Deutsche Luftschiffart Aktiengesellschaft, which can be translated as "German Air Navigation Company" but really was better known in English by the initials "DELAG." Service started with the airship "Deutschland," but it was damaged through inexperience in handling and the regularly maintained operations were not begun until 1911. Once operations were started on regular schedule, the service continued with what—even today—seems like remarkable regularity. The "Schwaben," which initiated the regular service in 1911, made over 100 successful trips in that year. Vastly encouraged by this performance, the "Viktoria Louise" and the "Hansa," each capable of carrying twenty-four passengers and a crew of twelve, were put into service in 1912. Electric cooking facilities were provided to eliminate

## ZEPPELIN AND THE MODERN AIRSHIP

risk of fire and hot meals were served on long trips. The "Viktoria Louise" made about 1,000 trips in this prewar service. However, as we have said, the outbreak of war put an end to these promising activities and the entire fleet was commandeered by the German government for military operations. A period of intense activity in construction followed and the Zeppelins became very active in air raids on allied cities, particular attention being given to attacks on London.

### *Other Airship Builders.*

Zeppelin, of course, was far from being the only worker in the airship field, although his development of the rigid airship ranks him head and shoulders above any other individual in the construction of displacement aircraft. As with airplane development, limitations of space prevent the inclusion here of anything like a complete recital of all of the workers in the development of the early dirigible balloons, or "airships," as the later types were called. Alberto Santos-Dumont, a Brazilian inventor who did his work in this field in France, undertook the development of his first dirigible balloon about 1897 and between that time and 1905 he constructed and flew a series that showed steadily improving performance. All of these were of the flexible gas-bag type as distinguished from Zeppelin's rigid type. Shortly after the story of the Wright flights came out, Santos-

## THE STORY OF FLYING

Dumont turned his attention to the airplane and ceased work in the airship field. Major August von Parseval, from 1906 to 1911 another contemporary of Zeppelin, was active in the construction of a type that became known as the "semirigid" airship. Instead of using a completely rigid structure like Zeppelin's or a flexible gasbag like Santos-Dumont's or others', Parseval used a compromise between the two. This provided a central structure capable of carrying and distributing to the gasbag all the vertical load, while still remaining more or less flexible in a lateral direction. This development was also taken up in Italy but terminated there also a few years after the close of the First World War.

### *Postwar Zeppelins.*

After the end of the war, the Zeppelin Company prepared to resume its prewar operations and constructed the "Bodensee" and the "Nordstern," both commercial transport airships. Each incorporated the improvements in design resulting from the intensive development of the war period; passenger accommodations were luxurious and compared favorably with those of ocean liners. Such had been the improvement attained during the war that the "Bodensee" and "Nordstern" were capable of attaining a speed of 80 miles an hour as compared with the 43- to 48-mile speeds of the prewar "Schwabben," "Viktoria Louise," "Hansa" and "Sachsen."

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The "Bodensee" went into service in August, 1919, and remained in nearly constant operation until operations were terminated by the action of the allied governments, apprehensive lest Germany become too powerful in the air. By that time the "Bodensee" had accumulated the total of about 32,300 miles in flight. Both airships were turned over to the Allies under the terms of the peace treaties, the "Bodensee" going to Italy and the "Nordstern" to France. For several years Zeppelin activities remained drastically restricted, its airship construction being limited to building of the "Los Angeles" for delivery to the United States as part of the reparations agreement. The restrictions were relaxed later as an outcome of the Locarno Treaty in 1925, whereupon the Zeppelin organization resumed activity by starting construction of the LZ-127. This was followed by inauguration of transatlantic service between Germany and South America and in 1929 the "Graf Zeppelin" completed a trip around the world.

In the period following the war, the Zeppelin Company entered into an agreement with the Goodyear Company, which resulted in creation of the Goodyear-Zeppelin Company for the purpose of building rigid airships in the United States. Upon this occasion a substantial part of the Zeppelin technical staff was moved from Germany to the United States and some airships were built for the U.S. Navy. A number of large rigid airships have also

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been built by the British since the war. The subsequent slowing down of airship construction as a result of some disasters in flight, combined with lack of helium for German commercial operations, has caused activity in this field to be extremely limited for several years. In the meantime, the airplane has now displaced the airship in overocean transport operations. However, the future of the commercial airship is likely to be affected by an important economic factor in its apparently lower cost of operation. For very long, unbroken trips (such as are entailed in overocean flights) its builders claim lower operating cost for the airship. Hence, it is quite possible that the airship and airplane may ultimately be found to fill different and more or less non-competitive fields. The present total eclipse of the airship should not be too readily accepted as permanent.

## Chapter IV

# The Incredulous Century

*“Might as Well Try to Fly.”*

WE MUST now retrace our steps over nearly a century to pick up the threads of our story of the development of the airplane. The nineteenth century was an age of rapid progress in engineering, yet it was frankly agnostic on the question of mechanical flight. This was the age in which the expression “might as well try to fly” had become a metaphor for the impossible. A modern reader, thumbing over the yellowed pages of old technical journals, is left with the distinct impression that editors of these bygone years regarded mechanical flight as far too imaginative to warrant space in their conservative publications. Taking the *Scientific American* as typical, mainly because of the universality of its interest, we find the editor ridiculing the January, 1847, proposal of a Mr. Wise of Lancaster to use for aerial bombardment a war balloon 100 feet in diameter. By September, 1848, we come across a brief reference to the reports of Stringfellow’s now historic experiments with flying models in London. To this the editor humorously appends the proposal that String-

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fellow's flying machine be used for "exploring the River Niger." A few months later the reports must have come back to mind, for the editor comments that "since that we have heard no more about it, and presume that it met the fate of its predecessors." By 1851 or so we find references to balloons and flying machines becoming more frequent, reflecting the progress actually being accomplished. But what is most significant is the absence of the humorous editorial comment that was formerly appended to each report.

### *Man-carrying Gliders Appear.*

In the second half of this century of incredulity there started a wave of experimentation with man-carrying gliders, representing a totally different method of attack upon the problem of mechanical flight. The first successful glide is believed to have been made in France by a sea captain by the name of Le Bris. The report of this glide originally came out through the publication of a novel of the period; hence doubt arose regarding its authenticity. Octave Chanute, who made an investigation of the report, became convinced, however, that the novelist had based this part of his story upon an actual happening. Le Bris is supposed to have studied the flights of the albatross on the French coast and decided to construct a glider patterned after one of these large birds. This he evidently did, and from all accounts

## THE INCREDULOUS CENTURY

it must have been a fearful and wonderful device. Yet the apparently authenticated reports say that Le Bris actually did make a glide of about an eighth of a mile on a main road near Douarnenez in about 1855. A man of small means, he had no funds to continue the work and after damaging a couple of gliders he was forced to give up his efforts. No extensive interest seems to have been taken in the work at that time, since this was the period when interest centered mainly upon the balloon.

### *The First Wind Tunnel.*

It was shortly after this time that scientific investigation began to supplant the cruder methods of earlier years in the efforts to achieve power flight. On a wave of popular enthusiasm for the activity the Aeronautical Society of Great Britain (predecessor of the present Royal Aeronautical Society) was founded in London in 1868 as the first scientific body devoted to aeronautics. By 1877 the first wind tunnel was in operation—an air duct about  $2\frac{1}{2}$  feet in diameter and some 13 feet long which was being used at the French Military Establishment at Chalais-Meudon to provide an artificial wind for testing airship models. Since this wind tunnel was used for strictly military purposes the results were held confidential and not published. In the last two decades of the century experiments in gliding were resumed by Montgomery in the United States and the

## THE STORY OF FLYING

Lilienthal brothers in Germany. The first glide recorded to have been made since Le Bris—and the first thoroughly successful glides on record—were some of 300 to 600 feet made by Professor J. J. Montgomery in California in about 1884. These were accomplished by jumping from the top of a sloping hill and gliding downward. Montgomery built many gliders between 1884 and 1894, dropping interest then until about 1903, when he resumed his experiments.

### *Lilienthal Brothers Take Up Gliding.*

Otto Lilienthal, who made history with his gliding experiments in Germany, was born in 1848 and began his aeronautical work in collaboration with his brother Gustav when he was only thirteen years of age. The two started their experiments in 1867 but were interrupted by the Franco-Prussian War, which called both brothers into the army. It was 1871 before they resumed their experiments, and the next 20 years were spent in studies that eventually led to many successful glides. Between 1891 and the death of Otto in 1896 they made over 2,000 glides, some of as much as 328 feet. Their gliding successes served to demonstrate the possibilities of mechanical flight, for as Captain F. Ferber put it later in the *Revue d'Artillerie*: "Since 1891, when Lilienthal . . . made his first flight of 15 meters, aviators have been in possession of a method." Despite his skill, Otto Lilienthal was killed by a fall in one of his gliders in 1896. It



FIG. 5.—Zeppelin's "Schwaben" in 1911 initiated the world's first regular passenger air service. (*Courtesy of Goodyear-Zeppelin Company.*)



FIG. 6.—The Zeppelin passenger airship "Hindenburg." (*Courtesy of Luftschiffbau Zeppelin G.M.B.H.*)

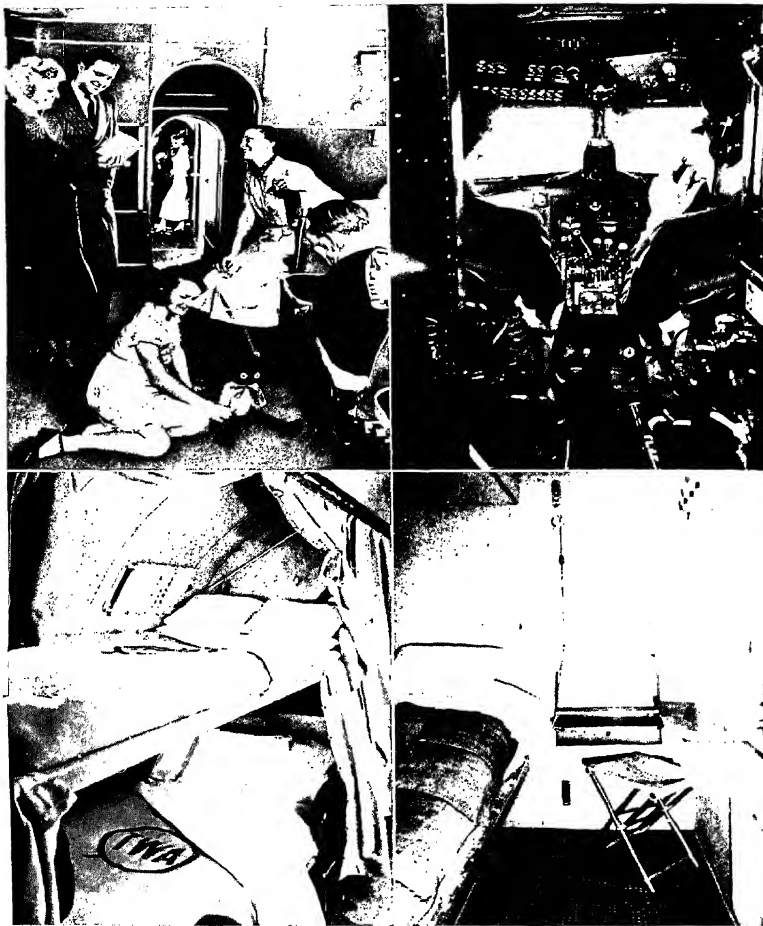


FIG. 7.—The Promenade, a unique feature of some of the large flying boats used on British air routes. (*Courtesy of Imperial Airways.*)

FIG. 8.—Even the ceiling has to be called into use in finding places for the innumerable instruments and controls of a modern transport airplane. (*Courtesy of United Air Lines.*)

FIG. 9.—Sleeping accommodations of modern airliners resemble those of a Pullman car. (*Courtesy of Transcontinental & Western Air, Inc.*)

FIG. 10.—One of the passenger cabins of a Zeppelin airship. (*Courtesy of Luftschiffbau Zeppelin G.M.B.H.*)



FIG. 11.—Focke-Wulf twenty-six-passenger airliner in flight. (*Courtesy of Deutsche Lufthansa A. G.*)

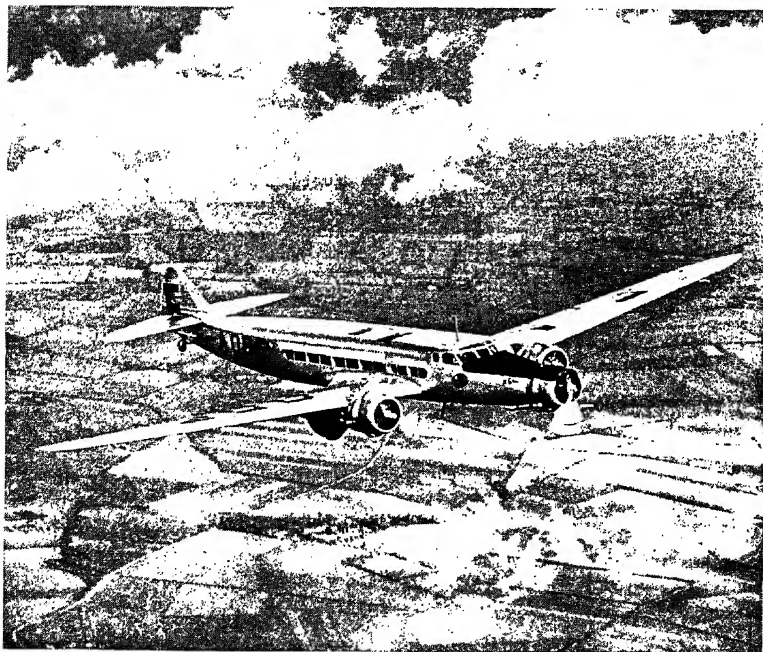


FIG. 12.—One of the modern French airliners en route. (*Courtesy of Air France.*)



FIG. 13.—The De Havilland Express, a type used on some British routes in the late thirties.

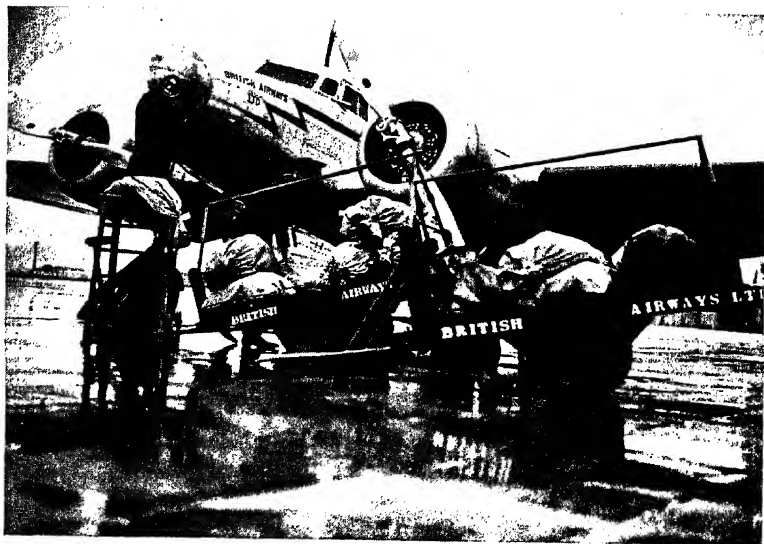


FIG. 14.—Loading one of the American-built Lockheed Electra liners used European routes.

*(Photographs courtesy of British Airways, Ltd.)*

## THE INCREDULOUS CENTURY

happened that an Englishman by name of Percy S. Pilcher who was also interested in gliding had visited Lilienthal the year before his fatal accident and had returned home enthusiastic over the demonstrations. Pilcher immediately began experiments of his own and was becoming quite proficient at gliding when he, in turn, met an untimely death in September, 1899, when a stay wire broke and caused the collapse of his glider during a test under windy conditions.

### *Chanute's Gliders Prove Stable.*

But the effort was not to die with Lilienthal and Pilcher, for the scene shifted to the United States, where Octave Chanute, the noted civil engineer already mentioned, had become interested also. Chanute's active work with gliders began shortly before the death of Lilienthal and he experimented with a greater variety of types, beginning with some resembling Lilienthal's gliders. Monoplanes, biplanes, triplanes and even six-plane gliders were included, about 1,000 glides being made in 1896 and 1897. By evolution he developed a relatively stable biplane glider and all his later types were biplanes. Chanute's gliders, like many others of their time, were designed to be controlled by the operator's swinging his feet to move the center of gravity and, on the whole, his later designs showed that they possessed more stability than those of any previous experimenter. Chanute took his experiments seriously and he foresaw com-

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mercial possibilities in flying, once man had mastered the art; his gliders were admittedly a development that he hoped would eventually lead to power flight.

While the foregoing gliding experiments were progressing, another group was attacking the problem from a different angle: direct power flight was being attempted without the preliminary of gliding. The work of both schools extended to just beyond the nineteenth century and both schools served to pave the way for the ultimate success of the glider. In the meantime, the rest of the world continued on its way, having little more than ridicule to offer the plodding workers who were nearing success in this quest of the ages.

## Chapter V

# Three Nearly Succeed

### *Sir Hiram Maxim's Research.*

IN THE closing period of the nineteenth century that witnessed the gliding experiments that we have just described, three men were experimenting with power airplanes. One was in England; one in France; and the third in the United States. Sir Hiram Maxim, the Englishman, first became interested in flying machines in 1856. He was then only sixteen years of age, but this interest had been handed down to him by his father, who had been speculating about the problems of the helicopter and had discussed his ideas with the boy. Maxim the son, however, was about thirty-two years of age before he really took the problem seriously and in 1872 he started to make drawings of a helicopter. With a truly scientific method of attack, he found a lack of the basic information needed for this design. Thereupon he began a series of laboratory experiments with models and he soon found that, to use his own words, "nearly all of the mathematicians are radically wrong, Professor Langley, of course, excepted." Maxim's tests were very extensive. More so, indeed, than is generally realized even to this day—for he was not given to broadcasting the results

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of all his experiments and his most generally known publication *Artificial and Natural Flight* gives only the barest outline of his work. At first he used a small wind tunnel, which would be considered crude by present standards but which was sufficiently accurate to show that there was something "radically wrong" with the information available on air resistance and the basis previously used for aerodynamic calculations. Later in his investigations Maxim made use of a whirling-arm type of testing device that carried his test models around a large circle through the air at high speed, thus permitting a closer approach to the actual conditions of flight. Not only did Maxim test wing lift, he also tested the resistance of different parts, he made tests of condensers for his steam engine and he tested propellers.

### *An Expensive Hobby.*

Maxim found, as so many others had found, that aeronautical research soon becomes an expensive hobby. By 1893, when he decided that he was equipped to proceed with the construction of a full-sized man-carrying craft, he had accumulated considerable information and he had made an equally considerable dent in his pocketbook. His airplane was completed and undergoing tests in 1894 and for that period it was an enormous craft. Its total wing area was 5,500 square feet when all the surfaces were in place. His naphtha-fired boiler and steam engine were capable of

### THREE NEARLY SUCCEED

delivering better than 360 horsepower—more than the power of any aircraft engine subsequently built until about the middle of the First World War! Nothing on so large a scale had been attempted by earlier experimenters. Perhaps it might have been better had Maxim confined his work to a smaller scale, since the subsequent wreck would then have represented a much smaller financial loss. During the test runs, Maxim's airplane was held down by a special guard rail to keep it from making a premature flight. He fully realized that he had not yet solved the problem of control and piloting, and he did not intend to risk the loss of his expensive craft. In addition, he wanted to demonstrate first that flight was a mechanical possibility. That much accomplished, the next step would be to experiment with methods of control. Several test runs were made and on the last one the boiler developed better than its usual pressure, giving the engine somewhat more steam than necessary for current test purposes. A speed of around 40 to 42 miles per hour was attained, whereupon the lifting effort of the huge craft became so great that it carried away a portion of the guard rail intended to keep it from making a free flight. Rather than risk a flight before he had everything properly prepared, Maxim sacrificed ambition to discretion and cut off the steam. Had he chosen otherwise, it is just possible that aviation history might have taken a different turn. As it was, the result was a more or less

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complete wreck of the craft but without the serious or even fatal injuries that might have followed a free flight. By this time, however, Maxim had sunk so much money into the experiments that he never decided to rebuild the machine. After the accident—in which he so narrowly escaped the honor of being the first man to leave the ground in a machine lifted by its own power—Maxim made a calculation of the lifting force actually attained. Including its own weight and the force required to break the heavy wooden guard rail, he estimated that his experimental airplane must have exerted a lifting force of around 10,000 pounds. Thus, at least, he had the satisfaction of actually demonstrating that it was possible to lift about *twenty times* as much as mathematicians, using the information formerly available, had calculated it was possible to lift with that wing area and horsepower!

### *The Captive Airplane.*

A strange by-product resulted from Maxim's efforts to recover a part of the \$100,000 or so that he had spent out of his own pocket upon these experiments. Most probably the idea was suggested by watching his whirling-arm testing device in operation. For it took the form of a "captive flying machine" consisting of a rotating arm from which were suspended small airplanes that lifted their own weight and that of their occupants when the arm was rotated

### THREE NEARLY SUCCEEDED

at sufficient speed. He actually built one of these devices and had it in operation at his estate of Thurlow Park in England. The plan was dropped because this first device was damaged by accident, whereupon observers (who were present for the purpose of passing upon it for public use) became unnecessarily alarmed about its safety. Before Maxim could make further efforts to put his captive airplane into use, an American inventor constructed a slightly similar device that was taken up so generally as to destroy the possible interest in Maxim's invention. This rival device was also called a "captive flying machine," but its cars had no wings, they did no real flying and they depended solely upon centrifugal force, which merely swung them outwards as they rotated. Before many years had passed, almost every country fair and amusement park in the United States had one of these devices and many appeared in Europe also. Despite the fact that his airplane had actually demonstrated its ability to lift more than its own weight, Maxim became rather discouraged by his failure. In an article describing his experiments, which he published in the *Scientific American* in 1898, he said he was convinced that the "aeroplane system is not practical for flying."

*Clement Ader's "Avion."*

A contemporary of Maxim was Clement Ader, who was associated with telephone development in France.

## THE STORY OF FLYING

Ader became interested in flight as early as 1872 and like those of many others his ideas originally leaned toward the ornithopter or flapping wing. Later he came to regard the airplane principle as more promising. He began work in this direction in 1886 and with the backing of the French government he constructed in great secrecy a steam-driven airplane. The first trials of this craft were made on October 9, 1890, and the results were held for many years as a closely guarded secret. Later the plane was claimed to have made a flight of 164 feet, although it was wrecked at the end of this hop. Ader's craft was a weird batlike machine with a span of 46 feet, equipped with a steam engine capable of delivering between 20 and 30 horsepower. The craft was reconstructed and again tried on October 14, 1897, but again wrecked upon landing after a hop of slightly less than 1,000 feet. Because of the secrecy surrounding the tests and the fact that no official information was given out until after the Wrights had successfully flown, most people are still skeptical regarding the claims of Ader's supporters.

*"Not Proven."*

If Ader's machine had shown even half as much promise as his friends would have us believe, then the ordinarily very capable French War Department would have made a rather stupid error in not immediately ordering a new machine constructed after

### THREE NEARLY SUCCEEDED

the first was wrecked. Indeed, the mere fact that the experiments were dropped would suggest that the craft had been a failure. At the same time, its secrecy might well be explained by a desire on the part of the French military to avoid criticism over the expenditure of something like \$100,000 on what must have seemed a "crazy experiment" at the time. Regardless of whether or not Ader's craft made the hops claimed, it still remains incontestable that each ended in a total wreck, from which we may judge that the machine very obviously did not possess two of the essentials of success: a reasonable degree of stability and some adequate means of control. In their classic *History of Aeronautics* E. C. Vivian and W. L. Marsh summed it up very concisely when they chose for the title of their chapter on Ader and Maxim the rather apt expression: "Not Proven."

#### *Langley Begins with Models.*

The American of these three contemporary workers on power airplanes was Dr. Samuel P. Langley, then Secretary of the Smithsonian Institution at Washington. Langley's dormant interest in mechanical flight was aroused by a communication read at the Buffalo meeting of the American Association for the Advancement of Science in 1886. He was much impressed by the success attained in France by Alphonse Penaud, who had been flying toy airplanes with rubber-band-driven propellers as early as 1870.

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Langley began experimenting in the same direction in 1887, building a series of rubber-band-powered models, some of which he flew in the upper hall of the Smithsonian building in 1891. "Endless numbers" of variations were tried, to use his own words. The success attained by these toys suggested the plan of experimenting with higher powered models in the hope of furthering the possibility of human flight. Consideration was given not only to steam but also to such widely different sources of power as gunpowder, compressed air, illuminating gas, gasoline, carbon dioxide gas and even electricity. Both alcohol and gasoline were studied as possible fuels. To provide stability Langley used a dihedral setting of the wings for lateral balance and a slight difference in angle of inclination between the fore and aft wings for longitudinal balance—the latter being further aided by the automatic action of the tail. This tail, called a "Penaud tail," after Alphonse Penaud, who first used it in France in 1871, could also be moved manually to provide control.

In Langley's own words, "The lateral part [referring to stability] is approximately secured with comparative ease, by imitating Nature's plan, and setting the wings at a diedral [this is his spelling] angle which I have usually found made 150 degrees." Similar principles are still applied by airplane designers to this day in order to provide or improve lateral stability. Like his contemporary Maxim, he soon

### THREE NEARLY SUCCEEDED

found that he had to discard most of the "theoretical" calculations that formerly had been applied to estimate the lift and resistance of inclined surfaces moving through the air. In this respect he checked perfectly the findings of Maxim, who reported that his test surfaces were lifting as much as twenty times what the old school of "scientific" calculators led one to expect. To provide a means of testing wings, Langley built at the Allegheny Observatory a whirling-arm device 60 feet in diameter. This could be rotated to give, at the end of the arm, speeds that (theoretically) could be varied from  $12\frac{1}{2}$  to 125 miles an hour. In actual practice, belt slippage somewhat reduced the top speed.

#### *Steam Models Follow.*

During 1892 and 1893 four steam models were built that represented two general types. None attained much success; more power was needed and all through his description of the results Langley dwelt continually upon this need. His next experiments were directed toward improving his engine and boiler. In 1894 further tests followed, only to end in failure from either structural or stability troubles in each case. In the following year he renewed his efforts to improve the output of his steam unit. With no design data to start with, nearly every conceivable type of trouble ensued in both the steam unit and the models themselves. In one case the wings would prove too

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flexible; in another, the model would dive into the waters of the Potomac before it was possible to determine what was wrong. It was December, 1894, before Langley attained any result that gave even the slightest encouragement; even it consisted only of a flight of a few seconds that ended by the model's diving ingloriously into the water. However, by May of the following year it seemed as though success was in sight, for, in rapid succession, flights were made of 2.8 seconds, 7.2 seconds and then  $10\frac{1}{4}$  seconds. The winter of 1895-1896 was spent in further rebuilding and redesigning and on May 6 of the latter year Langley found substantial cause for encouragement. One flight of 3,000 feet was followed immediately by another of 2,300 feet, the steam-powered models behaving well in their free flights and landing perfectly at the end. Alexander Graham Bell, of telephone fame, was privileged to witness and photograph many of Langley's model flights and of the May 6, 1896 flights he said, "I was extremely impressed by the easy and regular course of each trial." As a matter of fact, Bell was so much impressed that he was inspired to some original experiments of his own and thus came about his unique tetrahedral kites, of which we shall say more later.

### *Forty-two Pounds in Flight.*

Whereas Langley's rubber-band models were mere toys, these steam models were (for that time) of

### THREE NEARLY SUCCEEDED

rather significant size. One of them (No. 5) had a total area of 68 square feet and weighed 26 pounds; another (No. 6) had 54 square feet of area and weighed 27 pounds. His quarter-scale model of 1903 had an area of 61.4 square feet and the rather impressive weight of 42 pounds. These substantial masses propelling themselves through the air—the first as early as 1896—represented an important milestone on the road toward human flight. Until 1896 Langley had not planned to build a man-carrying machine. His idea was to content himself with using large power models to demonstrate the practicability of human flight. Others, he hoped, would be inspired by this experimentation to carry on from the point at which he left off. This plan, however, was destined to change through the fact that Theodore Roosevelt, then Assistant Secretary of the Navy, had drawn President McKinley's attention to the work—whereupon the latter took a personal interest in the remarkable success of the steam models. Anticipating its possible advantages in warfare, he urged Langley to design a full-sized man-carrying aircraft. In furtherance of this plan he appointed a joint Army and Navy board to look into the experiments and to report upon the practicability of carrying on the work with the objective of producing such a man-carrying aircraft. Langley really wanted to drop the experiments in 1897; having demonstrated with his steam models that flight was mechanically

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possible, he had no desire to go farther. Indeed, in that very year he wrote that he had "brought to a close" the part of the work that seemed to be especially his and that for its continuation "the world may look to others." McKinley's encouragement, however, caused him to change his plans and thus it came about that the spring and summer of 1898 were spent upon the design of a man-carrying craft, with Charles M. Manly serving as Langley's design engineer.

### *The United States Finances an Airplane.*

In the meantime, the Army Board of Ordnance and Fortification, duly impressed by the performance of the steam models, made its report. This was evidently very convincing, for near the close of 1898 the government allotted \$50,000 for the construction of a large machine. Almost immediately the order was placed for a gasoline engine that was to develop 12 horsepower and to weigh not over 100 pounds. It was expected that more power would be necessary and a duplicate engine was being considered. The engine order was placed in December, 1898, and the builder, S. M. Balzer of New York, undertook to make delivery by February 28 of the following year. The latter date came and went without Langley and Manly's getting any closer to having their engine. By August of 1900 the engine was still far from being ready and it was not developing anything like the power expected. The contract ended by paying full

### THREE NEARLY SUCCEEDED

price for the unsuccessful engine and by Manly's taking up the responsibility of carrying on the development. Parts of two engines were taken over, one a small and the other a larger model. Each was a five-cylinder radial type. Manly soon found that he had undertaken a gigantic task when he shouldered the responsibility of producing an engine capable of delivering the required power and keeping within the weight limit—which, incidentally, had been ridiculed as impossible of attainment by the most experienced engine builders of that day. Such was the current stage of engine development that spark plugs, coils, and similar equipment all had to be made especially for this engine.

#### *Manly Makes Progress on the Engine.*

In 1900, after much experiment and reconstruction, the large engine finally was coaxed into developing  $21\frac{1}{2}$  horsepower. At this stage of the development it weighed 120 pounds, above original expectations in power but (because of its greater weight) still below the current power requirements. According to Manly's calculations, 24 horsepower was required to fly; if the engine was to run overweight even more would be needed. This left a choice of two alternatives: to build a larger engine or to build a duplicate of the one they had. Since the work had already shown where further weight reductions could be made, Manly decided in favor of the one large engine. So

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the work started all over again. This new engine was designed to deliver at least 24 horsepower, but he had hopes of getting as much as 40 horsepower if all went well. How conservative were his expectations was shown later, when the same engine ultimately delivered 52.4 horsepower! Pending completion of the elusive engine, it was decided to build and fly a quarter-size model airplane as a check upon various design calculations. This was to be propelled by a gasoline engine and would serve to determine the effect of the many changes necessitated by current developments. After more disappointments, of the type to which Langley and Manly had now become thoroughly accustomed, this model was successfully flown at Quantico on August 8, 1903. Development of the big engine was going along well by now and in the latter part of 1903 the large machine was complete with its engine and ready for tests.

### *First Attempt to Fly the Full-scale Aircraft.*

Take-off from a launching track on the roof of a houseboat on the Potomac had been selected as the most generally advantageous method and thus the apparatus was set up. Day after day passed while the experimenters waited patiently for calm weather, reluctant to risk everything by a launching under adverse conditions. At last an opportunity came and at 12:20 P.M. on October 7, 1903, the first test was attempted. Here another disappointment awaited,

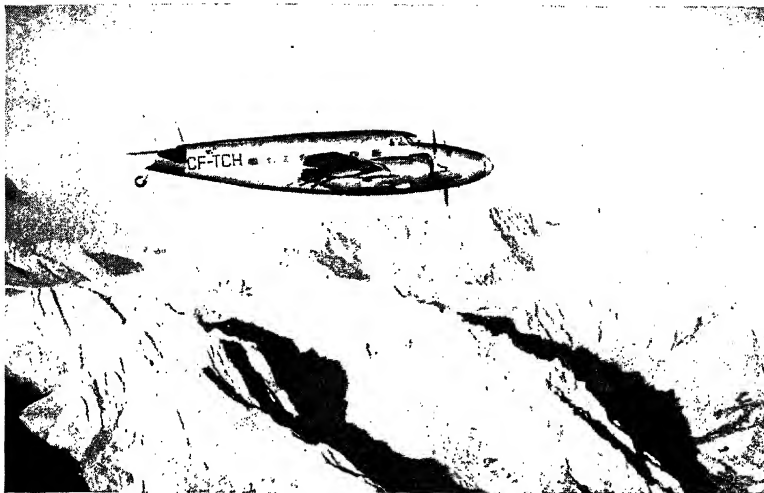


FIG. 15.—A Lockheed transport in service on the routes of Trans-Canada Air Lines. (*Photograph by J. H. Washburn.*)

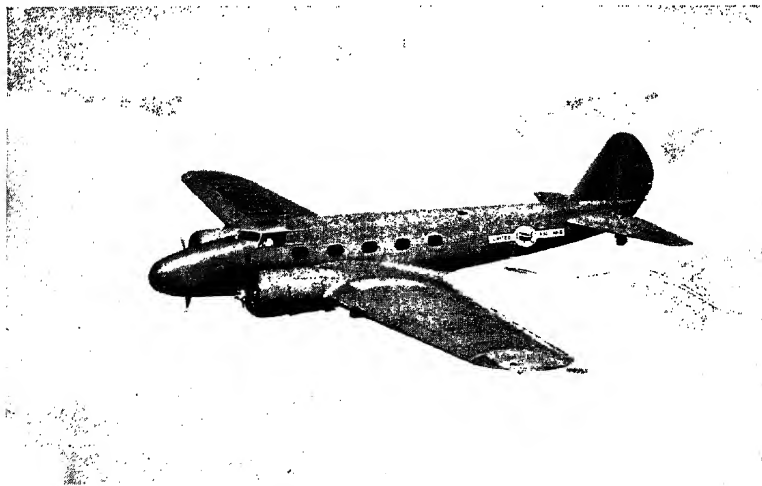


FIG. 16.—One of the all-metal Boeing transports recently used by United Air Lines.

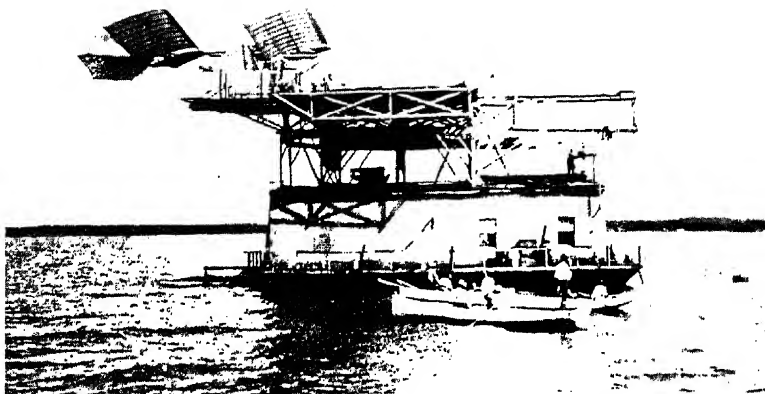


FIG. 17.—The full-sized Langley machine poised on its launching rail ready for the attempt of October 7, 1903. (*Courtesy of the Smithsonian Institution.*)

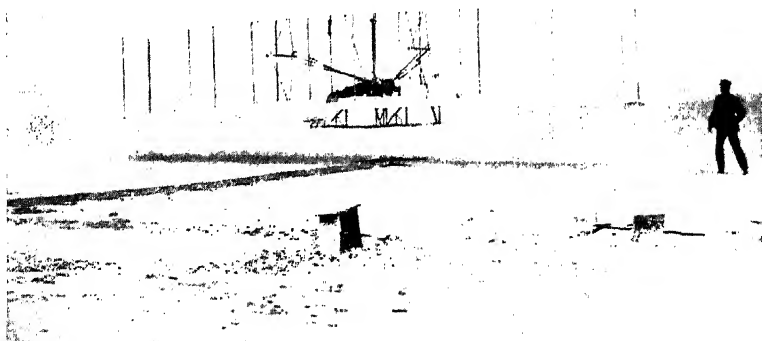


FIG. 18.—An actual photograph of the first successful power flight ever made by man; Orville Wright flying at Kitty Hawk on December 17, 1903. (*Courtesy of Orville Wright.*)

### THREE NEARLY SUCCEEDED

for the craft dived into the water as it left the rails and Manly, who had volunteered to act as pilot, might have drowned had he not succeeded in freeing himself under water. Langley really had intended to have the first trials made with a dummy instead of a man. However, the years of delay had become so irksome to everyone concerned that he allowed himself to be persuaded by Manly into giving permission for the latter to take the risk. Undismayed by the failure of the initial launching, they salvaged the machine, repaired it and prepared for a second attempt. After about a three weeks' wait for calm weather, suitable conditions were attained by December 8. A tugboat was obtained to tow the houseboat into position, but before everything was ready a gusty wind came up and again made conditions entirely unsuitable. By this time all funds were exhausted and it seemed, as Manly put it, a question of "now or never." Only a successful demonstration would induce the government to supply the funds necessary to carry on the work. Throwing discretion to the winds (largely because he saw no alternative) Manly decided to make the trial regardless of weather.

#### *The Second Attempt.*

The engine warmed up, he signalled for the start and the craft began moving down the launching track. Just before it reached the end, something

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went wrong. The tail dragged, the machine nosed up steeply and, turning over on its back as it left the rail, flopped upside down in the water, pinning the hapless Manly beneath it! In the few seconds that followed Manly thought his end had come. Under water and beneath the craft, he fought desperately to free himself from the machine. Only by diving clear of it was he able to save himself from drowning in the icy waters of the Potomac. Evidence collected after the accident pointed to collapse of the rudder and its subsequent entanglement in the launching gear as the original cause of the wreck. Once more the wreckage was salvaged as best possible, but funds were now exhausted and the daily press was heaping ridicule upon the experiments, leaving little hope of obtaining additional funds for reconstruction of the craft.

### *The Engine Makes a Startling Showing.*

A little more work was done on the engine, however, and by August, 1904, Manly had succeeded in pushing its output up to the amazing figure of 52.4 horsepower! This, be it noted, was for an engine with a net weight of 151 pounds or, complete with all of its accessories and cooling water, about 207½ pounds. For its time and for years later this was an almost unbelievable achievement. Many years passed before anyone built another gasoline engine that equaled this low weight of about 2¾ pounds to the horsepower.

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Langley died on February 27, 1906—only a few years after the ill-fated trials of his airplane, or “aerodrome,” as he called it. Although he did not have the satisfaction of actually accomplishing the first man-carrying power flight, he lived long enough to find himself vindicated by the success of the Wrights. By the irony of fate, this vindication came just 9 days after the second Langley crash. Such was the avalanche of adverse criticism that followed the Langley failures and such was the ridicule heaped by the daily press upon the head of its inventor that Langley’s machine was not publicly exhibited until some time after his death.

#### *Langley’s Craft Eventually Flown.*

After the ill-fated trials of 1903, the craft was returned to the shop, where it was left by the War Department in Langley’s possession for further experimentation. It remained there until 1914, when it was shipped to Hammondsport, New York, where it was equipped with floats and some other modifications were made. On May 28, 1914, it was flown with its original engine with Glenn Curtiss at the wheel. Several other short hops were made, ranging up to 5 seconds in duration and 150 feet in distance. The short duration of these brief hops, combined with the fact that changes had been made in the craft, gave rise to a controversy over the question of whether or not the craft would have flown in its

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original form. The most important changes were probably structural ones, including reinforcement of the spars. The controversy grew to some size and charges of unfairness were freely bandied about, but none of them served to add anything in the way of enlightenment; nor did they in the least alter the fact that Langley's craft actually made short hops with its original engine and in *almost* its original form. On the other hand, no one can question the fact that the Wrights were actually first to fly a man-carrying power airplane and in extended flights had demonstrated fully the effectiveness of their lateral-control system. Some years later, when acceptance of the Wright successes had completely changed public sentiment toward earlier experimenters with "flying machines," the Smithsonian felt emboldened to set up Langley's craft in the shop where he had done most of his work in the rear of the Institution building. In 1918 it was opened to public inspection, after having been restored to its original form. And thus ended the saga of the last of this earlier group of experimenters whom the world called "dreamers."

## Chapter VI

# Mechanical Flight at Last!

### *Two Boys Become Interested.*

WILBUR, elder of the two Wright brothers, was born on April 16, 1867, on a farm about 8 miles east of Newcastle, Indiana. Subsequently, his family moved to the city of Dayton, where Orville, the younger of the two, was born on August 19, 1871. One evening late in the fall of 1878 their father, the Reverend Milton Wright, brought home a toy helicopter as a small present for the amusement of his sons, then about eleven and seven years respectively. This was a flimsy device of bamboo, cork and paper, consisting of two screws driven by rubber bands. It did not last long in the hands of the young boys, but it left an indelible impression on their memories, for it represented their first contact with any device that was capable of mechanical flight. Some years later the recollection was sufficiently strong to inspire them to construct others of their own, which they made in progressively larger sizes, only to find that the larger they were the poorer they flew. Rather discouraged, they took up kite flying instead, but, as they grew up, they dropped this also as too much of a "kid's

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game." Their first business venture had no connection with aeronautics, being the operation of a small print shop which later led to the printing of a small four-page weekly newspaper. The printing business was begun by Orville while he was still in his teens and during the publication of the newspaper he was joined by Wilbur. Later, the two went into the bicycle business, operating a shop at 1127 West Third Street, Dayton, under the name of the Wright Cycle Company.

### *Lilienthal's Work an Inspiration.*

It was not until 1896, when reports of the death of Lilienthal reached them through the daily papers, that the brothers' interest in mechanical flight became really serious; Wilbur was then twenty-nine and Orville twenty-five. The story of Lilienthal's successes especially interested the brothers and they were much impressed by the fact that a man of the standing of Professor Langley should be so thoroughly convinced of the practicability of human flight. Spending the first few years of their interest in collecting and studying information on the work of others and on some scientific experiments of their own, they became avid readers of every book on aeronautics upon which they could lay their hands. Chanute's *Progress in Flying Machines*; Langley's *Experiments in Aerodynamics*; Means's *Aeronautical Annual* of 1895, 1896 and 1897; Lilienthal's reports

## MECHANICAL FLIGHT AT LAST!

and other such publications they devoured thoroughly. At an early stage of this research they noted the sharp division of experimenters into two schools: first, those like Maxim, who wanted to attack the problem directly by building a man-carrying machine; second, those like Lilienthal, Montgomery and Chanute, who wanted first to solve the problems of control, stability and piloting through gliding experiments, postponing the use of power until these problems were out of the way. The Wrights became consistent converts of the latter school, partly because they were not blessed with unlimited funds to spend upon construction and partly because the art of gliding appealed to them as being a good sport. (From their readings they learned of the mistakes of earlier experimenters—how some had attempted to gain stability by using a very low center of gravity only to find by practical experiment that to do so produced serious oscillations and brought results the very opposite of those expected. Others, such as Langley, made use of a “dihedral” wing arrangement, the wings being set to form a rather flat V, as seen from the front. This device, the experiments showed, was much more promising, for it *did* provide an important degree of stability in still air. On the other hand, in gusty air, it also tended to produce oscillations and, furthermore, it gave the operator no means of control. )

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### *Problems of Stability and Control.*

Studies of the failures of each previous experimenter led them to decide that stability was the real problem. These pioneers had apparently shown how flight could be accomplished; all that now seemed to remain was to find some means of providing stability and control. Later the brothers were to find that a more difficult problem was to construct a machine of sufficient aerodynamic efficiency to fly with the motors then available. After considering the disadvantages of previous methods of producing stability, they came to the conclusion that they needed a system that would be affected *as little as possible* by gusts—control being left to some manual system that they could not immediately devise but that followed later. Lilienthal, Chanute and other glider experiments balanced their craft by shifting the weight of their bodies or by swinging their feet. This was discarded by the Wrights at the outset as usable in none but the smallest machines. Thus, by a process of elimination, they came to the idea of warping the wings of their gliders to increase the lift on one side while decreasing it on the other. This apparently simple principle proved to be the answer, particularly when used in combination with the rudder to prevent an involuntary turn toward the side with the wing having the greater “angle of attack” and hence the greater resistance. Borrowing from the work of earlier experimenters, they devised their gliders as

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biplanes, taking the rigid wing structure originally invented by Wenham and improved by Stringfellow and Chanute and incorporating in it their warping-wing idea. In the Wright gliders, however, the main structure, although rigid under load, could be warped to change the angle of attack on either side. Their early studies and the paper work on their ideas took place between 1896 and 1900, during which time there was considerable other activity. Maxim, Ader, Lilienthal, Pilcher and Chanute all were active during at least a part of this period, but each, in turn, ended in disaster to either himself or his craft and one by one they dropped out. Langley alone continued his activities until almost the day of the Wrights' first power flight.

### *First Wright Gliders.*

The brothers began their practical gliding experiments at about the close of this period of activity at a time when the general public had once more become resigned to accept mechanical flight as an impossibility. Perhaps the best evidence of the general attitude is found in the fact that the U.S. Patent Office was then rejecting without examination all applications for patents upon devices intended to fly solely by mechanical means. And thereby hangs a tale concerning the Wrights' own patent application—but this we shall come to in due time. In the summer of 1900 they ascertained from the Weather

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Bureau at Washington that the North Carolina coast was best suited to their purpose and they chose the sand dunes of Kitty Hawk from which to make their first experimental glides. Generally speaking, their gliders followed Chanute's biplanes in arrangement and their first one was designed to be flown as a kite, carrying a man, in winds of 15 or 20 miles per hour. When they got to the stage of actual trials they found that much stronger winds were necessary; they had to abandon the plan of carrying a man and had to content themselves with operating the controls from the ground (by use of cords) while the glider flew as a kite over their heads. Although far less satisfying from the viewpoint of accomplishment and of no value in providing gliding experience, this arrangement had the advantage of giving their control system a practical trial without risk of life and limb. It also gave them confidence that they were working in the right direction with their plan of warping the wings.

### *More Gliding Experiments.*

In the summer of 1901 the brothers became acquainted with Octave Chanute and at their invitation he spent several weeks with them at their Kill Devil Hill camp 4 miles south of Kitty Hawk during their glides in the years 1901, 1902 and 1903. The first gliders fell far short of expectations in carrying capacity, although each one had been designed

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through careful use of aerodynamic data, such as the brothers found available from the work of previous experimenters. Chanute advised them that the trouble was due to no fault in their own construction, leaving, it seemed to the Wrights, no other explanation except that the published tables were highly inaccurate. With the failure of their craft actually to soar, they spent the summer and fall of 1901 on downhill glides and from these they found many other difficulties in their efforts to apply the textbook aerodynamics of that day. With changing angles of inclination the center of pressure of the air forces on the wings moved in a direction opposite to that recorded in the books. This circumstance was quite confusing. Then, when they warped the wing on one side, the craft turned slightly to that side and the wing *dropped* instead of rising, as anyone might have expected and as the two brothers certainly had expected. It was some time before they discovered that this drop was due to a very simple cause: the increased resistance slowed down the side with the greater angle—thus causing the turn and the almost simultaneous drop. At the close of their 1901 experiments many of these mystifying actions were not clear to them and they returned to Dayton very much discouraged—indeed they were rather uncertain as to whether they would carry their experiments further. It seemed that the further they progressed the greater and the more puzzling were the new

## THE STORY OF FLYING

difficulties that arose. Chanute tried to encourage them with the information that they had accomplished more than any previous experimenters and this helped in influencing them to continue.

### *Wind-tunnel Research.*

Finally they decided that, although they had taken up gliding as a sport, they would have to go into the problem scientifically if they were to get anywhere. "Reluctantly," as they said themselves, they assembled a small experimental aerodynamic laboratory at Dayton. With respect to their laboratory tests, the work of the Wrights was far more scientific and thorough than most persons realized until fairly recent years. Not content with collecting data on the results of other experimenters, they inaugurated extensive research of their own. Finding that their experiments failed to check with the technical information then available, in the fall of 1901 they constructed in their shop in Dayton a small wind tunnel measuring about 16 inches square and 6 feet long. This tunnel was even provided with a "honey-comb" to remove eddies. It not only served its purpose well but was probably the first tunnel in which model wings could be tested with reasonable accuracy. Upon the results of tests made in this little tunnel were based the designs of their successful gliders and their power airplane. Almost immediately after their tunnel tests began they found it necessary to abandon

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the figures derived from the work of earlier experimenters and to substitute their own new data. The wind-tunnel results often proved as mystifying as the performance of their gliders. Wing sections did not behave at all as might be expected and often results were so surprising that the brothers began to doubt the accuracy of their apparatus. However, they persisted in this research, spending their winters in Dayton in the laboratory and the summer or fall gliding at Kitty Hawk.

### *The Control Problem Is Solved.*

After their return home in the fall of 1901, they continued to think over the confusing response of their glider to the wing warping and they decided to try using the vertical rudder in combination with the warp in order to prevent the involuntary turn when it was attempted to correct lateral balance. With this in mind they built another glider and returned to Kitty Hawk in 1902. The glides were now so completely successful that they decided that the problem was solved at last. Thereupon they started work upon their applications for patents and, at the same time, upon the construction of what was to be their first power airplane. Here many new problems arose. When they came to build a propeller, for example, they found that marine propellers were designed mainly upon empirical (experimental) data. Hence they had to resort to the plan of treating their

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two propellers as if they were rotating wings and thus using their wind-tunnel data to calculate the forces. At first they tried to purchase a suitable engine, but none of the automobile manufacturers showed the least interest in building one so light as their requirements demanded. Having previously built a small gasoline engine for running the machinery in their bicycle shop, they decided to try building their own airplane engine. This they both designed and constructed in their own shop, turning out a four-cylinder horizontal type that would be judged crude by the standards of today but that was quite a remarkable piece of work for its time.

### *The First Power Airplane.*

Their airplane design called for a total weight of 550 to 600 pounds including the operator and an 8-horsepower engine. When it was ready, the engine, pleasantly surprised them by developing fully 12 horsepower, or fifty per cent more than had been calculated, thus allowing the addition of another 150 pounds in reinforcing of the wings and other parts. The engine and propeller combination proved to be distinctly more efficient than those used by others in previous attempts at mechanical flight. Orville Wright estimated that even their first propellers were about one third more efficient than those used by Maxim and Langley. Having been successful with gliders and anticipating similar success with

## MECHANICAL FLIGHT AT LAST!

their power airplane, the Wrights filed their application for a United States patent on March 23, 1903, while the airplane was still under construction. In due course of time their attorney found in his mail a formal notice of the decision of the patent examiners rejecting the application as covering a device that was "inoperative"—a decision vividly illustrating the esteem in which "flying machines" were held by the U.S. Patent Office in the year 1903! The application, of course, did not end here, for their attorney undertook the task of convincing the patent examiners of the practicability of the device and the Wrights' first United States patent was finally issued on May 22, 1906.

### *Back to Kitty Hawk for Trial.*

By the fall of 1903, the entire apparatus was complete and in September of that year the brothers were at Kitty Hawk assembling their craft in a wooden shed that served as a hangar, although hangars were not then known by that name. Before leaving Dayton, they had made a shop test of the chain drive without its propellers and found it necessary to reconstruct the shafts, using heavier tubing to withstand the shocks of the motor impulses. On Friday, September 25, they arrived at Kill Devil Hill near Kitty Hawk. Provisions and tools had been sent on ahead by freight. Their first job was to repair the shed that they had put up in 1901 and

## THE STORY OF FLYING

that had been blown off its posts by a storm shortly before they arrived. No sooner had the parts of the airplane and glider arrived than a storm came up with a wind that at one time reached as much as 75 miles per hour and gave them a stiff fight to save the whole camp from being blown away bodily. In the middle of this exceptional wind Orville climbed up on the roof to nail down the tar-paper cover that was threatening to rip off every minute. Three weeks were spent in putting the motor airplane together and any "idle" time was spent by getting in some practice with their 1902 glider that had been left in the building since the previous year but remained in good condition. The first run of their motor after its installation in the machine resulted in discovery of a failure in one of the propeller shafts. This had escaped notice in Dayton and there was nothing to do but return the shafts there for repair. It was the twentieth of November before these came back, but no sooner were they reinstalled and the motor started than a further succession of mechanical troubles came up. Just as these were straightened out and the airplane was ready for a test, bad weather visited them to delay matters some more. While waiting for weather to clear up, they made another test run of the motor, only to have a tubular shaft crack once more. This time they were replaced with solid shafts after the delay necessitated by Orville's having to return to Dayton for the new set.

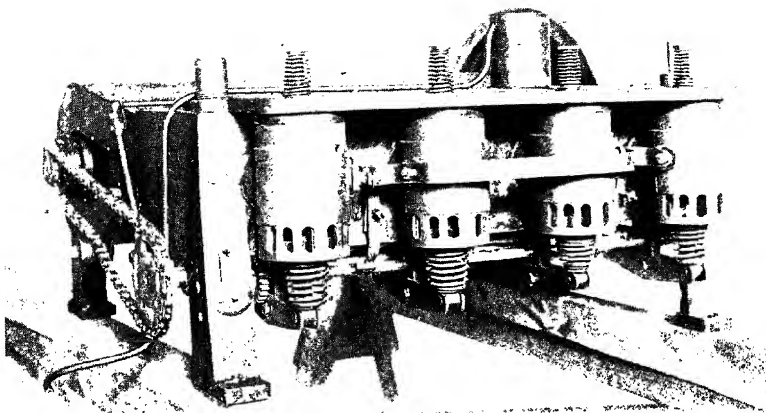


FIG. 19.—This little Wright motor was responsible for the first successful flight of a man-carrying power airplane. It delivered 12 horsepower and weighed 170 pounds without cooling water. (*Courtesy of Orville Wright.*)

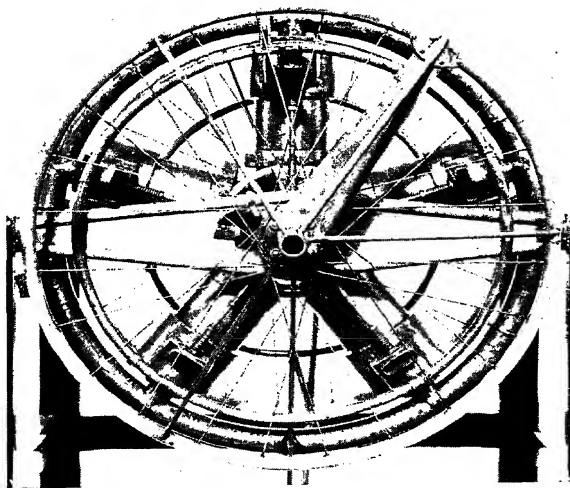


FIG. 20.—For Langley's full-sized machine Manly built this remarkable engine which, eventually, showed the startling output of more than 52 horsepower although it weighed only 151 pounds dry. (*Courtesy of the Smithsonian Institution.*)

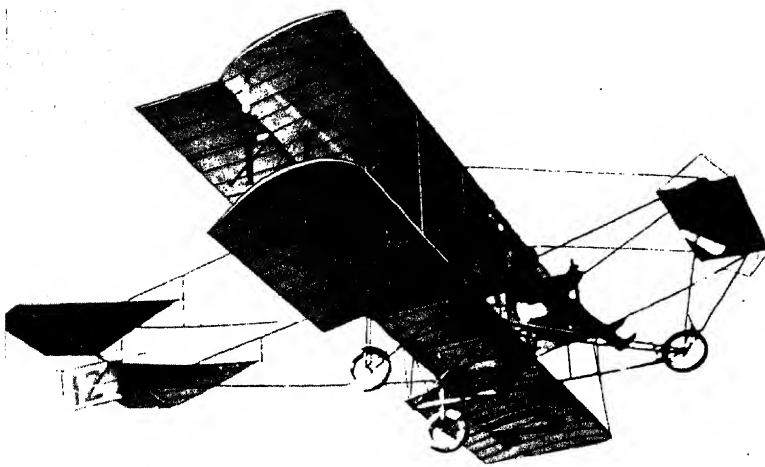


FIG. 21.—Glenn L. Martin's airplane of 1909 slightly resembled a "Curtiss pusher type" of those early days. (*Courtesy of Glenn L. Martin Company.*)



FIG. 22.—The Curtiss JN-4d, which became known affectionately as the "Jenny," was used extensively for training flyers in the First World War. (*Courtesy of Curtiss-Wright Corporation.*)

## MECHANICAL FLIGHT AT LAST!

### *The First Attempt at Power Flight.*

It was December 11 before Orville returned with the shafts and by the next day the machine was ready once more, but the wind was now so light that the airplane could not have been taken into the air in the short run permitted by the monorail track of their launching gear. On the fourteenth they decided to move the craft over to one of the hills in order to take advantage of the downgrade as compensating for the slight wind. The brothers flipped a coin to decide who would have the honor of making the first flight and Wilbur won. Everything was put in readiness and the signal to start was given. Down the track went the airplane with Wilbur at the controls. However, things did not proceed as smoothly as anticipated, the craft rose prematurely, turned too much, stalled, and then settled to the ground after a downgrade hop of 105 feet that took  $3\frac{1}{2}$  seconds. The whole performance was most unsatisfying since the craft had moved downgrade, had given no proof of its ability to sustain itself in level flight and had finally landed with a crash that broke one of the landing skids. In consideration of these qualifications, the Wrights have consistently refrained from claiming this hop as their first true power flight. It took two days to make the necessary repairs and the craft was not ready until the late afternoon of December 16, too late to consider any further attempt that day. So it was decided to wait until the next morning.

## THE STORY OF FLYING

The morning of December 17 dawned cold and raw, with the puddles from recent rains frozen over and a brisk wind blowing from the north. On the whole, it seemed a most inauspicious day on which to attempt what they hoped would prove to be the first power flight of man. By 10 o'clock, however, the brothers decided to make the attempt and put up their prearranged signal to notify the crew of the near-by lifesaving station, who had asked an opportunity to witness the tests and volunteered to help in handling the machine as they had on the attempt of the fourteenth. The track was laid out near the little building that served as living quarters, the men alternately retreating to the shelter of the cabin to warm themselves at the fire in a stove improvised from an empty carbide can.

### *Man Flies at Last!*

By the time they were ready there had arrived in response to the signal J. T. Daniels, W. S. Dough and A. E. Etheridge of the lifesaving station, W. C. Brinkley of Manteo and Johnny Moore, a boy from Nags Head. These five were to witness the first sustained power flight by man. Wilbur had had his turn on the attempt of the fourteenth, and this trial was to be made by Orville, who took his place on the wing after the motor had been warmed up. At about 10:30 the signal was given to start the craft down the track. It got under way slowly, having to

## MECHANICAL FLIGHT AT LAST!

accelerate against a 27-mile wind, and Wilbur ran alongside it holding a wing tip to steady the machine until it had gained sufficient speed to make the wing-warping controls effective. Just as it took off, one of the lifesavers took a photograph that will pass down to posterity as the first picture ever taken of a man-carrying airplane in actual flight! The negative is now in the possession of Orville Wright and the print reproduced elsewhere in this book was kindly furnished by him. As might be expected, this first flight was of short duration and rather irregular, the irregularity due partly to the inexperience of the pilot and partly to the gusty wind. It lasted only 12 seconds and covered only some 120 feet, but it was the first true power flight with control fully demonstrated ending in a good landing. Commenting upon this flight years later, Orville Wright said that in the light of subsequent experience he would never have considered attempting a flight in a strange machine in a 27-mile wind even if he had known that the machine had already flown and was safe. He looked back with amazement, he added, upon the audacity of attempting this flight under the circumstances! So closely were events following upon each other in this period that Langley's "aerodrome" crashed on its second attempt at flight just 9 days earlier and most of the daily press—blissfully ignorant of the Wrights' success—was still ridiculing the professor!

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### *Two More Flights Follow.*

Despite their enthusiasm, the rawness of the wind forced all to retire to the building for a short time to absorb some of its warmth before the next attempt was made. At 11:20 the second flight started, with Wilbur as pilot. In duration it was nearly the same as the first, but the distance covered was about 75 feet greater. Orville followed with a third flight of 15 seconds and about 200 feet; the fourth and last flight of the day was made by Wilbur. This lasted almost a full minute and covered a distance of 852 feet, but the frame of the frail craft was slightly damaged upon landing. After this last flight the entire group were standing around discussing the results when a gust of wind started to overturn the machine. Everyone rushed to save it and Daniels hung on so tenaciously that he was carried away with it and badly bruised from tumbling around in it several times as it turned over. Fortunately, he was not seriously hurt. However, the machine was damaged sufficiently to end all hopes of further flights that year. Only the group of men previously mentioned had witnessed these flights, for the Wrights had not invited reporters to be present. Thus one may scan the pages of the daily papers of Friday, December 18, 1903, only to find that many of them carried not a single line of reference to this important event of history. Even when the brothers did give out

## MECHANICAL FLIGHT AT LAST!

their story, the press in general received it with skepticism.

### *The Return to Dayton.*

The brothers returned to Dayton thoroughly elated by their success despite the fact that their machine had been wrecked by the wind; their four demonstrations had satisfied them that the problem was solved. This enthusiasm, it turned out later, was slightly premature, for the machine possessed the essentials for flight, but the pilots still had a lot to learn about flying. In the spring of 1904, flights were continued at Huffman Prairie at Simms Station, 8 miles east of Dayton. Except that it was stronger and heavier, the new airplane used there was similar to the one tried at Kill Devil Hill. But it proved to be more capricious, for the engine began to "act up" on the first few occasions and prevented actual flights. A number of reporters were present, and after the failure of the machine to fly they left disappointed. They even showed little interest later and did not return on future occasions when they heard of subsequent successful flights. The Wrights made their first complete circle in flight on September 20, 1904, and on November 9 they made four complete circles of the field in a flight lasting 5 minutes. Here some further problems arose, for the turns showed that some questions of stability still had to be answered. At times the action of the airplane was thoroughly

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mystifying, but eventually the problem proved to be largely a matter of piloting and some adjustment of the controls. In September, 1905, they were making extended flights, up to several miles, under excellent control. By this time, however, the flights had begun to attract so much attention that the Wrights discontinued activity because of the crowds that collected.

### *Many Still Skeptical.*

Even after reports of the flights began to seep into daily papers, many persons still remained skeptical. There had been so many false reports in the past that these were accepted only as additional evidence of some reporter's gullibility. Even as late as January 3, 1906, the *Scientific American* carried a report of flights in France under the heading, "Wright Aeroplane and Its Fabled Performances." Nevertheless the stories evidently inspired the editor to do some checking of his own, for in April the same periodical carried as authentic news the report of a statement sent by Orville Wright to the Aero Club of America. Although more general than in the United States, recognition abroad was not yet universal. At about this time, a German aeronautical magazine carried a report of the flights. In his effort to express what evidently seemed to him derision adequate to this occasion, the editor found it necessary to mix American slang with his German. For

## MECHANICAL FLIGHT AT LAST!

the story was headed "Ein Amerikanischer 'Bluff.'" By 1907 the flights had become generally accepted and efforts to emulate their success began to be made by many others in almost every part of the world.

### *Commercializing Their Success.*

It was about this time that the brothers suspended their flying to devote their time to business negotiations. First efforts to market their invention met with little encouragement in the United States, initial acceptance coming in France and England. Indeed, it was December 23, 1907, before their own country had reached the stage where it was willing to give the brothers, or anyone else, a contract for one airplane. For this \$25,000 was offered; the airplane was to prove its ability to carry two men totaling 350 pounds and gasoline for 125 miles at 40 miles per hour. Penalties were provided for lower and premiums for higher speed, with 36 miles an hour as the minimum acceptable. Even at this late stage many editors wrote up the story as if they thought that the War Department had lost its head. Because of the necessity of testing and demonstrating this Army machine, flights were resumed in 1908 and, desiring to avoid crowds, the Wrights returned to their original location at Kitty Hawk. In accordance with their current practice, in this new design built for the U.S. Army, they placed the pilot in a sitting position instead of having him lie on the wing, as they had

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done in the original airplane—the prone position having been used at first in order to decrease air resistance. The 1908 Army machine also had a new and larger engine (developed in 1906–1907) with its cylinders set upright instead of horizontally. When the craft was delivered to Washington public skepticism was so general that no one paid any attention to it and only a few soldiers were present to witness its first flight. Early on the morning of September 9, 1908, Orville Wright took off and made one flight that lasted 58 minutes. The effect was electrical! Despite the fact that only a few had witnessed this flight, news of it spread with the speed of lightning. Before the craft took off for its second flight, at 4:30 that afternoon, it seemed as though the whole city of Washington had abandoned its duties to crowd itself onto the flying field.

## Chapter VII

# Aviation Tries to Find Itself

### *The "Daily Mail" Prize.*

AFTER the Wrights' first power flights, the next really outstanding event in aviation was Bleriot's flight across the English Channel. For its time, this flight represented an achievement relatively greater than the first flights across the Atlantic. The summer of 1909 saw three rival flyers in France awaiting opportune weather to attempt a flight across the Channel for a £1,000 prize that had been offered by the *Daily Mail* of London. It is an interesting reflection on the attitude of the period that the average person thought the *Daily Mail* stood very little chance of losing its money. There were even some who considered it poor sportsmanship to post a prize for such "impossible" performance! Nevertheless, three flyers appeared willing to take a chance. Count Lambert had a Wright biplane at Wissant; Hubert Latham, then a newcomer in the public eye, had his Antoinette IV monoplane in a field at Sangatte near Calais; and Louis Bleriot, a very persistent experimenter, had his eleventh machine, a monoplane, at Les Baraques, also near Calais.

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Showing an excellent spirit of cooperation, the French government placed fast torpedo-boat destroyers in the Channel ready to follow the flyers and pick up those who might have the misfortune to land in the water—a precaution that, it turned out, was very much needed. The Marconi Company established radio telegraph (it was “wireless” in those days) communication between Sangatte and a Dover hotel, while the entire civilized world watched and waited for news of the attempts. July 19 saw the first effort with Latham’s take-off. This, however, proved a failure and he was forced down in the water. With the charming *sang-froid* that endeared him to the world, he sat calmly in the floating wreckage smoking cigarettes until he was picked up—still perfectly dry!

### *Bleriot Flies the Channel*

Next came the attempt of Bleriot. Rising from French soil at the unearthly hour of 4:41 on the morning of July 25, he headed out across the water in the direction of England with one of his country’s torpedo boats trying vainly to keep up. Although the weather had been clear earlier, a slight mist came up that blotted out both sides of the Channel and the torpedo boat. For a time he had simply to let the airplane take its own course since on this history-making flight he did not even have a pocket compass to provide guidance. Perhaps in compensation for his troubles with ten earlier airplanes

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Dame Fortune smiled that day—and he finally came to earth near Dover after completing the crossing of 31 miles in 37 minutes and thereby earning the plaudits of the entire world. Europe was hysterical with excitement and Bleriot became the hero of the day. Following the failure of his original attempt, Bleriot's rival Latham had ordered another airplane and he was awaiting its delivery when the news of Bleriot's success reached him. Despite the fact that his opportunity of being first had now passed, Latham decided to make another attempt for his own satisfaction. So on July 27, with the cheering for Bleriot literally still ringing in the public ears, he set out once more in a second Antoinette monoplane. Again he met with failure, this time coming down in the water only 2 miles short of his mark. About a month after this, on August 22, the first great aviation meet was opened at Rheims—the meet at which Glenn H. Curtiss, the experimenter from Hammondsport, New York, won the Gordon Bennett Speed Trophy and, with it, world fame. At this meet, many builders were represented, the airplanes including those of Bleriot, Delagrangé, Esnault-Pelterie, Farman Brothers, Levavasseur, Voisin, and the Wrights as well as Glenn Curtiss.

### *New York City Sees Its First Airplanes.*

The world was now awakening to the spectacular nature of flying and when the Hudson-Fulton celebration was held in New York City in the fall

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of 1909 the management decided that some airplane flights would prove an additional attraction to the celebration. With creditable impartiality, both the Wrights and Curtiss (whose work is described in the chapter following) were invited to participate. Orville Wright was then in Europe, but Wilbur arrived at Governor's Island in New York Bay on September 20. Curtiss arrived about a week later and both remained tinkering with their machines while they were waiting for the opportunity to make some flights, which high winds prevented until the twenty-ninth. On that date, Wright circled around the Statue of Liberty and on October 4 he flew from the island up the Hudson to a point opposite Grant's Tomb, where he made a turn and flew back. The airplane used on this flight was the regular Wright model with skids. To guard against the risk of loss or personal injury from a forced landing in the river, Wright bought a canoe in the city on the day before his flight. This he covered with canvas and tied to the bottom skids before taking off. Fortunately, however, the flight was completed without any untoward event and the canoe was not called upon to prove its utility as the Wrights' first flotation gear.

### *Aviation's First Boom.*

By the middle of 1909 individual experimenters were building airplanes of every conceivable variety in almost every part of the world, with the activity

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in the United States at least as great as anywhere else. Strenuous efforts were being made to solve the problem of building light engines and many concerns were turning out engines; some of these were very creditable, some were fair and others, hopelessly unreliable. It was at about this time that several American builders of two-stroke cycle marine engines made a determined drive to capture the aviation field for this type—but of this we shall say more later in a sketchy outline of engine history. Many of the unusual achievements of this period have long since been forgotten. Few of the modern flyers know that Matthew B. Sellers, who was later to serve on the Naval Consulting Board during the World War, was then flying his little four-plane machine and making short hops with a Dutheil-Chalmers engine that delivered only 4 horsepower at 1,500 revolutions per minute! Even when “revved up,” it barely attained the maximum of 5 horsepower. Shortly after this the first inherently stable airplane appeared in England. This was the unique tailless biplane designed and built by Lieutenant J. W. Dunne, who used the principle of extreme sweepback combined with a negative angle in the rearwardly extending tips of his wings in order to attain a high degree of stability. The craft was flown at Eastchurch on May 27, 1910, with its pilot keeping his hands entirely off the controls for a distance of about 2 miles. This was an amazing achievement for its time, for most airplanes were then highly unstable. As

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a matter of fact, the Dunne biplane was really *too stable*—it insisted upon “flying itself” instead of responding docilely to the actions of its pilot and for this reason it never became very popular. In the meantime, steady improvement in the stability of the conventional airplane left no particular need for the Dunne.

### *Government Research Aids Flying.*

With so much activity in airplane construction, the need for more information on aerodynamics became pressing and in 1909, in order to meet this need, England created its famous Advisory Committee for Aeronautics, which did a tremendous amount of pioneer research in the testing of wing sections and airplane parts and which still continues to make many very important contributions to aviation. Some years later, early in 1915, the United States followed this lead by creating its National Advisory Committee for Aeronautics. In the following year this body established, at Langley Field, Virginia, an experimental laboratory that has since grown to be one of the finest and best equipped of its kind in the world. Now included in its extensive and well-rounded research facilities are a tremendous wind tunnel that is capable of testing full-sized fighting airplanes and a towing basin more than half a mile long that is capable of testing models of floats at speeds of up to 80 miles an hour—or well in excess

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of the normal speeds of take-off. Then its many special types of wind tunnels include the "free flight" type for testing the stability of models in a condition simulating free flight; smoke tunnels for illustrating by lines of smoke the flow of air over wings; and an ultra high-speed tunnel for studying resistance of the air at speeds corresponding to the speed of sound—about 750 miles an hour. Since its inception, the National Advisory Committee for Aeronautics has rendered tremendous aid to the American aviation industry through its research work. Among its accomplishments have been the development of low-resistance engine cowling, more efficient wing sections, and performance improvement resulting from its engine-location studies and its tests of flying-boat hulls. As evidencing its appreciation of the Committee's work, the American aviation industry gave its unanimous endorsement to creation of the second N.A.C.A. research laboratory, which is being constructed in California.

### *Some "First" Things*

To get back to our earlier story, however, the period of 1910 to 1914 was one continuous succession of "first" things. The first experimental use of radio for sending a message from an airplane was made in August, 1910, by the Canadian flyer J. A. D. McCurdy, himself a "wireless" expert. At the Sheepshead Bay aviation meet held at New York, McCurdy

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flashed from his airplane to H. M. Morton, former chief engineer of the De Forest Company, the message: "Another chapter in aerial achievement is recorded in the sending of this wireless message from an airplane in flight—*McCurdy*." This, incidentally, was New York City's first real aviation meet. Organized and conducted by Curtiss, it gave the city its first opportunity to witness extensive flying. Although originally planned to run only 3 days, it attracted such attendance that it was continued for 3 more. The first aerial express on record was a shipment made in November, 1910, when P. O. Parmalee, one of the Wright flyers, carried 70 pounds of silk from Simms Station (near Dayton) to Columbus for the Morehouse-Martens Company, a Columbus dry-goods house. The distance flown was about 58.3 miles, the time 59 minutes and the "tariff" collected for the trip by the Wright Company was \$71.42 per pound. Not very long after this, early in 1911, there appeared the first "all-steel" airplanes. One was Walter L. Fairchild's monoplane, which was wrecked on February 11. This was followed by Captain Baldwin's "Red Devil," which appeared in the spring. Neither was entirely justified in its "all-steel" claim; both were fabric covered and the Baldwin machine even had ribs of wood. Nevertheless, the two efforts represented a definite departure from the "stick-and-wire" structures then in general use.

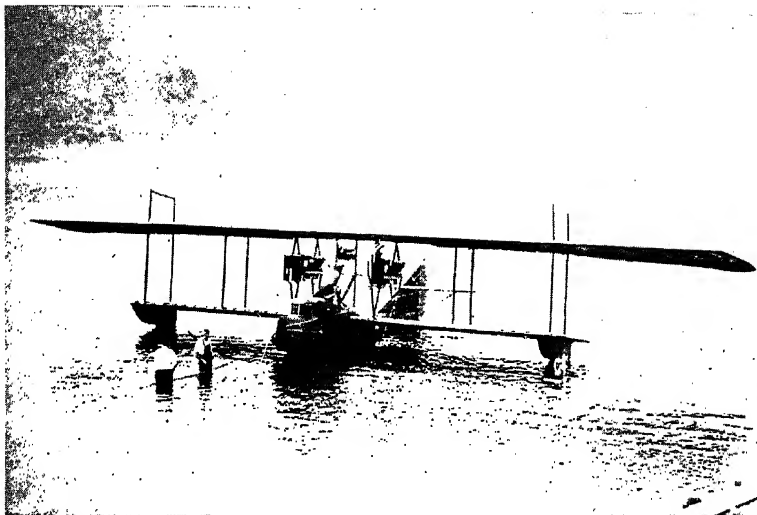


FIG. 23.—The Curtiss “America” was originally built to fly the Atlantic in 1914, but these plans were frustrated by the First World War. (*Courtesy of Curtiss-Wright Corporation.*)

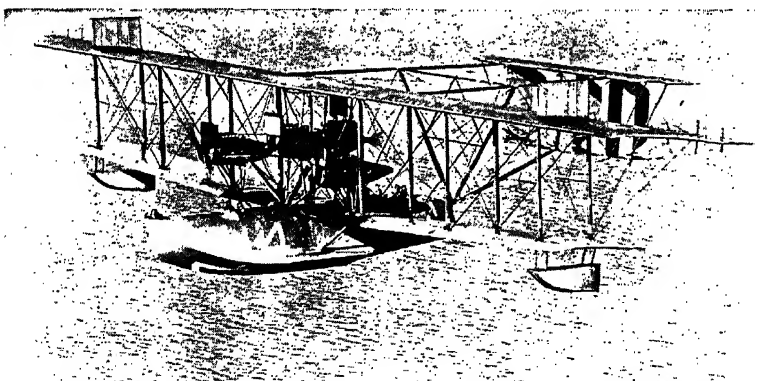


FIG. 24.—This United States Navy flying boat NC-4 flew the Atlantic in 1919. (*Official photograph, United States Navy.*)

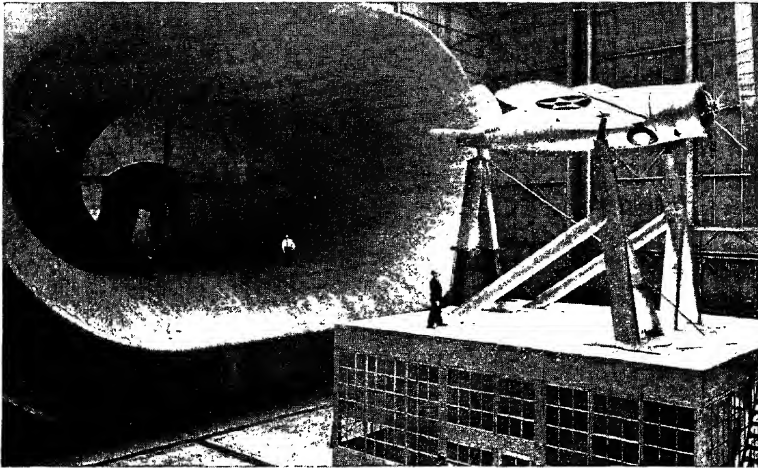


FIG. 25.—This enormous wind tunnel of the U.S. National Advisory Committee for Aeronautics makes it possible to test a full-sized fighting airplane such as the Brewster shown here. (*N.A.C.A. photograph.*)

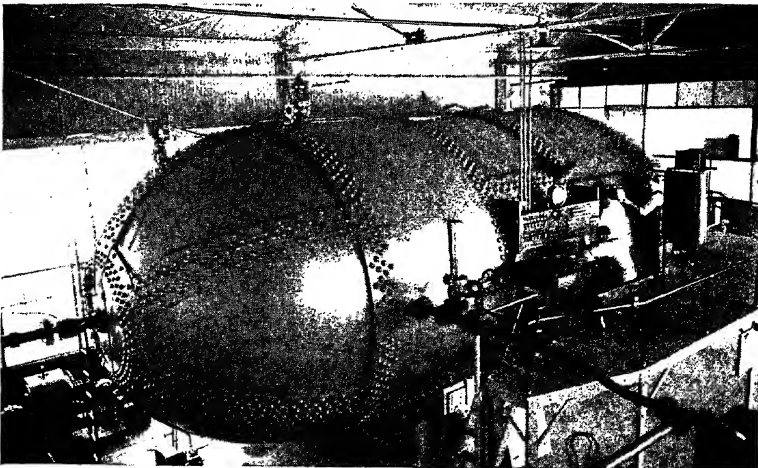


FIG. 26.—The compressed-air tunnel of the U.S. National Advisory Committee for Aeronautics uses pressures up to 300 pounds to the square inch and has been found of tremendous value in studies of high-speed flight. (*N.A.C.A. photograph.*)

*Bell's "Tetrahedral" Airplane.*

We have previously mentioned Alexander Graham Bell's interest in flight, which began in 1896, when he had an opportunity of witnessing some of Langley's model flights. Looking for some principle that would produce inherent stability in airplanes and make slow landings possible, he began to experiment with the multicellular principle, building large kites formed by many little cells of triangular surfaces, which he called "tetrahedral" kites. In December, 1907, his man-carrying kite "Cygnet," with a passenger, was towed across a lake by a tugboat and showed "good stability" in a 21-mile wind, although it was subsequently destroyed with the impact of landing. This kite consisted of 3,393 cells totaling 1,966 square feet of surface and its weight with floats and passenger was 600 pounds. The attainment of flight by the Wrights did not entirely stop Bell's work with his tetrahedral kites, but he proceeded to build an airplane of this type, "Cygnet III." Several flights were made in this weird airplane by the Canadian flyer J. A. D. McCurdy in Nova Scotia in March, 1912. The weight of the tetrahedral airplane was 540 pounds, including its 70-horsepower Gnome engine but exclusive of the weight of its 160-pound pilot. The "Cygnet III" made about 43 miles an hour, a speed that compared fairly well with that of the ordinary airplane of its day, although not equaling the speed of the faster airplanes.

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### *More "Firsts."*

The year 1911 saw the first air mail carried, although the flights were merely demonstrations and not regularly maintained services. The first demonstration was in England on September 9, when mail was carried between Hendon and Windsor. A couple of weeks later, Earle Ovington staged a demonstration in the United States by carrying mail between Nassau Boulevard and Mineola, Long Island, a distance of only a few miles. This "service" was operated for a week—September 23 to 30—with the cooperation of the Post Office Department. Although it was to be many years before electric starters were to become standard equipment on airplanes, the first actually installed was built in April, 1914 by the Hartford Suspension Company, automobile shock-absorber manufacturers, for use on Robert J. Collier's flying boat. The electric motor was so arranged that it was first brought up to high speed before it was engaged; thus the motor momentum was used to help overcome the initial starting resistance of the cold engine. In the spring of 1913 the first "big" landplane appeared. This was the Sikorsky "Aerobus," the second model of which, called the "Ilya Mourometz," made a test flight on February 25 at St. Petersburg (now Leningrad), Russia, in which it carried sixteen passengers for 18 minutes. With its total weight of 2,860 pounds and over-all width of 121 feet, it was considered enormous. Four Argus

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engines were used, delivering a total of 400 horsepower. The large cabin, first of its kind in any airplane, was electrically lighted and even was heated by the exhaust of the engines.

In the surge of activity of this period, we must not forget the beginning of the automatic stabilizer that, many years later, was to develop into the "automatic pilot" mechanism used on modern air liners. The Sperry Gyroscope Company had been working on the problem of automatic stability for several years and on January 21, 1914 Lawrence Sperry sailed for Europe with a device that he had been testing at the Curtiss plant at Hammondsport for the previous 18 months. In France, on July 2, he made a demonstration of the efficiency of this device that won for him a \$10,000 prize.

### *Aviation Tries to Find Its Place.*

Throughout all of this period, aviation was struggling to find its place in the scheme of things. Its first commercial application came with the "flying circus"—used to furnish an added thrill at country fairs. At first this "circus" was merely an exhibition of simple flying or even an exhibition of inactive airplanes on the ground. The dangers of flying, great as they were, became enormously exaggerated in the publicity "ballyhoo" used to draw in crowds and flyers became supermen whom people flocked to see. As the thrill began to wear off, pilots were forced

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to the expedient of looping and similarly spectacular stunt flying in their effort to hold public interest. They also introduced the custom of taking up passengers for very short flights at prices of \$5 or \$10 a person. During this period the invention of the airplane certainly should have brought tears of joy to the eyes of publicity men. Never before had an invention been conceived that held the public interest and imagination so completely as did the airplane. Press agents were quick to grasp the opportunity and for a time it seemed as though no publicity plan was complete unless some part of it centered around an airplane—regardless of how far-fetched the relationship had to be. However, such publicity became overworked; the public began to lose interest in airplanes as too obvious vehicles for ballyhoo; the initial enthusiasm for flying waned—and thus aviation's first boom came to an end shortly before the First World War.

## Chapter VIII

# Curtiss and the Flying Boat

### *Another Bicycle Builder Takes Up Flying.*

WE HAVE already made some references to Glenn H. Curtiss, who became the most outstanding contemporary of the Wrights but who is best known as the inventor of the flying boat. Curtiss was born on May 21, 1878, at Hammondsport, a small wine-producing town in the western part of New York. Like the Wrights, he was graduated from the bicycle business, having opened a shop of his own in Hammondsport in the spring of 1900. Before long Curtiss decided to try a small gasoline motor in one of his bicycles; later he developed this idea, incorporated it in his business and thus started a train of events that was to land him in aviation. His cycle motors grew in size and Curtiss began to create a reputation by the winning of many motorcycle races. In 1906 he built a motorcycle the like of which has never been seen before or since; this had an eight-cylinder 40-horsepower motor and with it Curtiss made a record of 137 miles an hour at Ormond Beach, Florida, in January, 1907. In the meantime his reputation as a

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motor builder had reached Captain Thomas Scott Baldwin, who was looking for something like this to use as an engine for his airship. He bought a Curtiss motorcycle engine and found it so satisfactory that several others followed and in the winter of 1904-1905 he commissioned Curtiss to build a water-cooled four-cylinder engine for his latest airship. Curtiss followed this up by serving as Baldwin's engineer, an undertaking that so aroused his interest in flying that he became one of the group that Alexander Graham Bell organized as the Aerial Experiment Association in 1907. The others were Lieutenant Thomas Selfridge, J. A. D. McCurdy and F. W. Baldwin. Curtiss was now in aviation with both feet! This little group built and flew several airplanes, Curtiss constructing the engines and collaborating in the designing and building of the airplanes. He became adept as a flyer and was beginning to establish a reputation in that field when, as mentioned earlier, he won the Gordon Bennett Cup at Rheims in 1909 and thereby catapulted himself into world fame as a pilot as well. By this time he had transferred his energies from motorcycles to flying and the building of airplanes and aviation engines as a business.

### *The Flying Boat Is Conceived.*

Almost immediately after the airplane had demonstrated its ability to fly, experimenters in some parts of the world turned their attention to the idea of an

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apparatus that could be taken off from the surface of water instead of land. Curtiss was among the first to attempt this when, in 1908, he tried to develop a machine capable of rising from the water, but his original experiment was a failure. The machine selected was the "June Bug," second of the experimental types built by the Aerial Experiment Association. It had been flown with its wheel-type landing gear in July, 1908, and, toward the end of that year, Curtiss attached a set of floats. Thus equipped, he attempted to take off from the surface of Lake Keuka, but without success. The small power of the engine and the crude design of the floats made it impossible to get the craft into the air. For a time he dropped the idea, although he retained his opinion that a successful type of flying boat could be developed. In the meantime, in France, in March, 1910, R. M. Fabre made the first take-off from the surface of the water, followed by a short flight in his float-equipped monoplane. It was nearly 3 years after his first attempt before Curtiss found time to get back to the float idea, for the intervening period had been one of great activity in exhibition flying. The winter of 1910-1911 found the Curtiss group at San Diego engaged in carrying passengers, instructing Army and Navy officers in flying, as well as continuing experiments in airplane development. Here the float idea was revived and a practical design developed that made it possible, after some painstaking experi-

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ments and discouraging failures, to get off from the water and to make a thoroughly successful flight.

### *The First Real Flying Boat.*

The craft, of course, was still merely a land airplane with a set of floats in place of the wheels; to the mind of Curtiss it marked only the beginning of a logical development. Not content with resting here, he started upon the construction of an improved model that he designed especially for water use. The first of this type was constructed secretly at Hammondsport late in 1911 and was given its initial tryout in San Diego Bay in January, 1912. It represented a type of construction radically different from what had already become accepted as conventional "Curtiss type." A hull that bore a close resemblance to a boat took the place of the original floats and in this hull was placed the engine—located in front of the pilot and passenger instead of behind and above them, as in the Curtiss landplanes. Tractor propellers were driven by chains in this first flying boat, although in later models this principle was altered, Curtiss's design reverting to the older arrangement of a single pusher propeller mounted directly on the engine. Watertight bulkheads were introduced for the purpose of providing compartments that would keep the craft afloat on the water in case of damage to the hull. The success of the Curtiss flying boat inspired others to experiment

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with this innovation and a distinct type of craft thus came into existence.

### *The "America" Type.*

The seaworthiness of the flying boat gave birth to an idea that the Atlantic Ocean might be crossed by such craft, since the hull could be depended upon to keep the craft afloat at least for some time if a landing in mid-ocean became unavoidable. Consequently, in 1914, Rodman Wanamaker made a contract with Curtiss for the construction of a super flying boat for the specific purpose of attempting just such an Atlantic crossing. This boat was to be named the "America" and, with its wing span of 74 feet and gross of 5,000 pounds, was to exceed in weight any previously built airplane or flying boat. It was to be equipped with two 200-horsepower Curtiss engines. The "America" development resulted in some innovations that turned out to be most important improvements in flying boats, the most outstanding and distinctive of these being the "side fins" that were added to its hull. These were not planned in advance. During tests it was found that the great weight of this big boat made the bottom surface of its hull insufficient for "planing" on the water at sufficient speed for taking off; to increase this area without widening the entire hull, extensions ("fins") were added to each side. Work on the "America" was well under way when the First World War

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broke out and Commander John Porte, of the British Navy, who was to have piloted it, was recalled to service in England. The original purpose of this flying boat was then abandoned, but its type was continued and many similar craft were built. Porte evidently returned to England with glowing reports about the possibilities of the "America," for the British Navy was inspired to order a fleet of them for its submarine patrol service. Thus, although the "America" never did have an opportunity of crossing the Atlantic under its own power, many of the "America" type finally were crated and sent overseas to be reassembled and flown in England.

### *Flying Boats Grow Bigger.*

These British orders put the Curtiss organization for the first time in a position in which really ample funds were available for development work. Orders for boats of the "America" type were followed by the production of larger and better types, which followed in rapid succession, increase in size being particularly marked. This increase reached an extreme in the huge Curtiss Model T, a triplane flying boat that weighed about 25,000 pounds when it was loaded and that was designed to be equipped with four 250-horsepower Curtiss engines. This great boat measured 134 feet from tip to tip of its wings and had a tail that was as large as the ordinary airplane of that day. Because of the secrecy necessitated by war conditions, almost

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nothing was published about this big machine and even in the flood of information released after the close of the war it appears to have been overlooked. Only one of the type was actually built, this being constructed for the British government in 1916 and shipped to England in sections. Assembled in England, it was flown experimentally with several different engine installations. It was found, however, that the purpose for which it was designed was filled more efficiently by the smaller sizes employing two instead of four engines. Hence no replicas of the big Model T were built. Although constructed back in 1915 and 1916, this craft remained for several years the largest airplane or flying boat ever built. Other large types were produced later, including the famous Felixstowe boats built in England and the Navy-Curtiss "NC" boats built in the United States. After the war this type of airplane was used to cross the Atlantic Ocean, one of the outstanding achievements in aeronautical history and the fulfillment of the dreams of Curtiss and Porte—but of this we shall say more later.

## Chapter IX

# The Patent Suits

### *The Wrights Take Legal Action.*

DURING its early years, the aviation industry was the setting for a patent fight of such importance as to warrant a place in our story. Many flights having demonstrated the success of the Wrights' control mechanism, other experimenters were quick to incorporate it or some equivalent in their machines. Some of these contemporary builders tried to avoid patent infringement by the use of different mechanisms. Glenn Curtiss probably had this idea in mind when he adopted for his airplanes the interplane aileron that had been developed by Alexander Graham Bell and others, including Curtiss himself. This device was first used in America by the Aerial Experiment Association although a somewhat similar system had been used slightly earlier in France on a glider built by Robert Esnault-Pelterie. It seems quite likely that Curtiss considered the interplane aileron as not only a noninfringement upon but even a possible improvement over the wing-warping arrangement of the Wrights. The Wright Company, however, held that these alternate methods of lateral control

## THE PATENT SUITS

(despite visual difference) still involved the application of the principles covered by their patents and in this claim they were eventually upheld by the courts. At an early date Curtiss organized the Herring-Curtiss Company, which soon became the Wright Company's most formidable competitor. Curtiss and his company thus became the subject of the first legal action in aviation, although suit was soon brought against the French flyer Paulhan when he tried to bring some of his airplanes into the United States. On September 30, 1909, the Herring-Curtiss Company and Glenn Curtiss were, upon application of the Wright Company, served personally with a court order requiring them to show why they should not be restrained from making and selling the "so-called Curtiss aeroplanes." Thus began a legal battle that extended over many years and held the aviation patent situation in a very unsettled state until the strife was ended by adoption of the cross-licensing agreement of the Manufacturers Aircraft Association in 1917.

### *The Wright Company Wins First Suit.*

First victory went to the Wright Company when, on January 3, 1910, the U.S. Circuit Court in Buffalo handed down a decision granting preliminary injunctions restraining Curtiss and the Herring-Curtiss Company from "manufacturing, selling or using for exhibition purposes the Curtiss aeroplane." The

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Curtiss plant, however, was permitted to continue in operation by posting a \$10,000 bond in connection with the injunction. Shortly after this Curtiss won a temporary victory when, on June 15, the courts vacated the temporary injunction on the grounds that the alleged infringement was "not so clearly established as to justify a preliminary injunction." Although it bore no relation to the Wright patent case, Glenn Curtiss became involved in another lawsuit at about this time as a result of internal friction that developed within the Herring-Curtiss Company. Curtiss and his group took legal action to compel A. M. Herring to turn over to the company certain patents as well as to restrain him from disposing of any of his stock. Following this disagreement, Herring withdrew and associated himself with Burgess, the Marblehead yacht builder. Thus, in February, 1910, there appeared the Herring-Burgess airplane, which closely resembled the type originated by Curtiss but which had skids in place of wheels and no ailerons.

### *The Burgess License.*

For several years, while the Wright patent suit was being threshed out in the courts, permission to manufacture airplanes under their patents was granted in only one case. This was the license issued to the Burgess Company and Curtis—the Greely Curtis of this firm having no connection with Glenn H.

## THE PATENT SUITS

Curtiss. This Marblehead firm was licensed to build airplanes under the Wright patents for a payment of \$1,000 for each airplane plus a further royalty of 20 per cent of the price of all parts sold, including engines and propellers. Burgess apparently operated under this arrangement for a short time and then obtained a license under the Dunne patent. Thereafter, he constructed the Dunne type of airplane, which used no manually operated lateral controls and was thus entirely clear of the Wright patents. The next decision in the Wright-Curtiss case came on January 13, 1914, when the U.S. Court of Appeals handed down a decision more or less confirming the former decisions in this case and in the case against Paulhan. This decision upheld the broad interpretation placed upon the Wright claims and left them completely victorious in the United States. Shortly after, the Wright Company's license policy was liberalized and in June, 1914, the company announced its willingness to grant licenses upon the payment of a fee of \$1,000 to cover the calendar year. In addition, there was asked a further payment of \$25 for each day that the "machine is operated, used or exhibited for or in prospect of profit, price or reward." At about this time, a report was published stating that Orville Wright had bought back from the original New York financiers the stock of the Wright Company and that thenceforth the company's policies would be directed by him.

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### *Settled at Last.*

The airplane patent situation remained in this stage in the United States until it was on the verge of entering the First World War. In January, 1917, the Secretary of War and Secretary of the Navy asked the National Advisory Committee for Aeronautics to investigate the airplane patent situation in the hope of working out a solution that would avoid payment of excessive royalties by the government. At almost the same time Congress appropriated \$1,000,000 for the purchase or the acquisition by condemnation of basic airplane patents. In the meantime, the Wright patents had been acquired from the original company by the new Wright-Martin Aircraft Corporation, of which we shall say more later. As an outcome of the National Advisory Committee's recommendations, the Manufacturers Aircraft Association was organized July 24 of the same year in order to effect a cross-licensing agreement that had been worked out with the owners of the most important patents. This ended for good the most serious phase of the patent strife. Under the arrangement all the airplane builders agreed to cross-license their patents and each paid to the association a license fee of \$200 for each airplane built. After deducting operating expenses, this money was used to pay royalties to the owners of all patents that came within the scope of the agreement, starting with the Wright and Curtiss patents and distributing the funds



FIG. 27.—The luxurious seating arrangement of a United Air Lines' Skylounge airliner. (*Photograph by Grignon.*)



FIG. 28.—Breakfast in bed on Sunday morning—or any other morning—is only a matter of choice aboard a sleeper of American Airlines.



FIG. 29.—Eastern Air Lines' flight steward serves a fair passenger a cup of coffee as she enjoys a five-course dinner while traveling at 175 miles an hour.



FIG. 30.—Luncheon is served by Pan American Airways aboard its Clipper Ships en route to Bermuda.

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in accordance with the values assigned to each patent. Soon after, the fee was decreased to \$100 for the period of the war and it has been readjusted downward several times since. The cross-license agreement is still in operation and new patents are constantly being added—the earlier patents having long since expired. Present rate of payment under this agreement is one-eightieth of one per cent of the selling price of the airplane without engine or propeller.

### *Other Patent Suits.*

While the prewar patent fight was proceeding in the United States, the Wright patent situation was developing in various ways in other countries. In Great Britain, the patents were fully recognized and prior to 1914 full license rights were granted for a cash payment of \$75,000. In France the patents were contested but were fully upheld by the courts. The situation in Germany took a rather heartless turn when the Wrights' claims were ruled invalid on the grounds that Octave Chanute, in a lecture given earlier, had mentioned that the Wright brothers warped the wings of their gliders and airplane. This, it was ruled, constituted sufficient disclosure to invalidate the entire patent under the peculiar provisions of the German law. Thus the Wrights, through no fault of their own, lost all patent protection in Germany. Another patent dispute came up to trouble Glenn Curtiss when his claims to the invention of the flying boat

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were questioned in the courts by an inventor by the name of Janin. Laying claim to prior invention, Janin started suit in 1913 and several years of litigation followed before the U.S. Circuit Court of Appeals held, on December 15, 1921, that Curtiss was the original inventor of the flying boat. This was about the last case of its kind relating to airplane patents in the United States, all of the principal aircraft builders having settled their differences with the adoption of the cross-licensing agreement.

## Chapter X

# The First World War

### *A New Military Weapon.*

SUMMER of 1914 found Europe peaceful on the surface, but a smoldering spirit of war threatened to break into open conflagration at any moment. By June 28 armies were still dabbling with airplanes half-heartedly, without much conviction as to their military usefulness, when two shots from the pistol of an assassin rang through a street in the obscure little Serbian town of Sarajevo. Events followed with kaleidoscopic rapidity and within a few weeks the most disastrous war of history (to that date) was under way. It began with no military appreciation of the airplane and no clear conception of its place in military operations; in looking backward from the vantage point of well over a quarter of a century, it seems inconceivable that military authorities failed so completely to visualize its possibilities. The first attempts to use the airplane in war were in observation and reconnaissance. Pilots were sent up to fly over the enemy lines and bring back reports or photographs of what they saw. The conception of aerial combat apparently never entered the heads of military authorities, for the first pilots were sent up unarmed except for their service revolvers. These they soon found useful in keeping enemy airplanes at a respectful dis-

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tance and thus aerial combat began. Hand grenades soon followed and next came the idea that there might be some advantage in the dropping of bombs upon munitions plants to destroy the morale of the workers; no one really thought that substantial damage could be accomplished by aerial bombing. The use of machine guns quickly followed the use of revolvers and it was not long before the Germans had devised a mechanism for synchronizing the machine gun with the propeller to permit shooting through the disk of its rotation without hitting the blades. This brought on combat in real earnest and out of it came the long list of war "aces," or combat pilots who had records for bringing down numbers of enemy airmen. Among the leaders were the German Baron von Richthofen, the French Captain René Fonck, the Canadian Major William A. Bishop, the French Captain Georges Guynemer, the American Captain "Eddie" Rickenbacker and Colonel Harold Hartney, as well as many other British, French and German flyers. The Fokkers and Taubes became well-known airplanes on the German side, the Nieuports, Spads, Sopwiths and De Havillands, on the side of the Allies. Later came the bombers: German Gothas, the Allies' Handley-Pages and many others and with these developed special sighting and bomb-dropping devices.

### *America's War-munitions Boom.*

Germany apparently was first to realize the value of the airplane in warfare, whereupon the Allies

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began to exert an effort to catch up, resulting in bringing some of the British war orders to the American aviation plants. Curtiss was the first to benefit when flying boats, training airplanes and engines were ordered in quantities far beyond the imagination of the earlier years. So began an aviation war boom that continued until the signing of the armistice. The Curtiss Company moved the seat of its chief activities from the cramped quarters at Hammondsport to the city of Buffalo, renting a part of the plant of the Thomas Motor Car Company and, shortly after, building its first new plant at Churchill Street. As the war continued and the ever-increasing importance of aviation became more and more evident, other orders and still further expansion followed. Early in 1916, Orville Wright sold his interest in the original Wright Company to a syndicate of New York bankers headed by William B. Thompson, H. P. Whitney, T. F. Manville and others, Wright himself being retained as consulting engineer. In March of the same year Edward M. Hagar, formerly president of the Universal Portland Cement Company (a U.S. Steel subsidiary) was elected president of the Wright Company. The principal stockholders were now William B. Thompson, A. H. Wiggin, William E. Corey, Percy A. Rockefeller, Ambrose Monell, E. C. Converse, C. H. Sabin, John D. Ryan and Henry R. Carse. At about this time the company began its expansion by acquiring the Simplex Automobile Company in order to enter engine

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production on a large scale. In August the company was merged with the Glenn L. Martin Company and at about this time the new management announced that it had secured the manufacturing rights for the Hispano-Suiza aviation engine and had received an order for 450 of these engines from the French and Russian governments, work on which was being carried on in the old Simplex plant at New Brunswick. Shortly after this, the enlarged Wright-Martin Company withdrew from airplane construction in order to concentrate all its operations upon engine building. It still, however, retained the Wright patents and the industry was notified later that payment of royalties would be expected of all airplane builders.

### *The United States Enters the War.*

By the end of 1916 or the opening of 1917 it had become evident that the United States was going to be drawn into the war and many large financial groups began to acquire an interest in airplane and engine plants. Already many of these plants had felt the beginning of a war boom through foreign orders and expansion actually started before the United States joined the Allies. The Mitsui interests of Japan acquired the Standard Aircraft Corporation, the General Vehicle Company had arranged to build Gnome and Le Rhone aviation engines under license, the old L-W-F Engineering Company

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had passed from the hands of Lowe, Willard and Fowler into those of a Rochester group, the Sturtevant and Thomas-Morse plants, having ample capital of their own, were starting to expand. No sooner had the United States joined the Allies than they called for more and still more airplanes as (next to man power) their greatest need. Airplanes were demanded in quantities that were entirely beyond precedent. Tremendous production plans were shaped up in Washington and to carry these out the Aircraft Production Board was formed. It was at this stage, or just prior to it, that a group associated with the automobile industry made a determined effort to obtain complete control of the aircraft industry. The airplane business, it was argued, was far too small and too poorly organized to produce the quantities of airplanes required. So successful was this campaign that almost complete control of the aircraft production program was given to men associated with automobile manufacturing. Howard E. Coffin, an automobile manufacturer with no previous aviation experience, was made Chairman of the Aircraft Production Board—although, in justice to Coffin, be it noted that he rendered much constructive service to aviation some years after the war. Most of the other important positions went similarly to automobile men. One later result of this policy was a series of scandals and investigations that kept the daily press busy for the entire period of our participa-

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tion in the war and even for some years after it. Of these scandals we shall say more later.

### *Big Orders Go to the Automobile Industry.*

First outcome of the policy was illustrated in April, 1917, by the organization of the Dayton Wright Company by a group of automobile men who had not previously been connected with aviation. Apparently to make a good "front" as well as to acquire rights to a desirable name, Orville Wright was retained as consulting engineer. Since the size, experience and general importance of the Curtiss Company was such that it could not be ignored, this firm was awarded orders at an early date. Its JN-4d was adopted as standard for training of pilots and orders were also placed for its flying boats. It was not until a few months after the United States had actually entered the war that many of the other airplane builders were given contracts. Then the Boeing, Vought, L-W-F, Gallaudet, Burgess and other plants began to expand also. Altogether, the industry underwent a tremendous boom, although the cream of the orders, outside those placed with the Curtiss Company, went to plants that had been organized mainly for wartime production, most of which had suspiciously close association with the automobile industry. When the United States entered the First World War it had in production no aviation engines of sufficient power to equip the De Havilland-4 airplanes

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that had been decided upon as standard for front-line use. Similarly large power was desired for the big Curtiss flying boats that had previously been equipped with Curtiss 200-horsepower engines. For these larger engines it now became a question of whether to adopt some foreign design for immediate production or to proceed with a new American one. The latter course was chosen and this choice gave rise to further scandals, although with much less justification than in the case of the airplane-production program.

### *The Liberty Engine.*

Such were the circumstances that produced the Liberty engine; and, as it finally developed, the country probably did better than it could have done had it started out to copy some foreign engine. One evidence of this is the facility with which (just as it was going into production) the Liberty size was increased to meet overseas demands. As soon as the decision had been reached that a new design was to be developed, two outstanding engine designers were given charge of the work. One of these men was Jesse G. Vincent, chief engineer of the Packard Motor Car Company, who had developed an aviation engine for his company; the other was J. G. Hall, of the Hall-Scott Motor Car Company of San Francisco, builders of the well-known Hall-Scott aviation engines. Hall and Vincent, who thus met for the first time, were given the problem of producing a design

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of an engine to deliver from 275 to 300 horsepower. Later this horsepower was raised to over 400 in order to meet the insistent demands for greater power on the part of overseas military officials. The two engineers held their first conference on June 3, 1917, in a room in the Hotel Willard in Washington and this conference lasted from the afternoon until about 2:30 the next morning—during which time the general outline of the engine design was agreed upon. Vincent's experiments with light steel cylinders had been so satisfactory that it was agreed to use this type for the new engine and, likewise, the narrow V was adopted to decrease head resistance.

With this much determined, the drafting work continued under high pressure, using two working shifts 24 hours a day, Vincent and Hall alternately taking turns at working a 24-hour shift. If one may credit the highly dramatized press releases emanating from the wartime publicity bureau, neither man left the suite of rooms for 5 days. This report, however, was published some time later, for the greatest of secrecy surrounded the entire work until after construction of the production engines was well under way—whereupon the engine was publicly announced as the "Liberty" motor.

### *The First Two Liberties.*

So rapidly was this work pushed under pressure of war needs that the first experimental engine was set

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up and nearly ready for initial tests about 28 days after the drawings had been started. Two of these engines were built, one being sent to Pikes Peak for running tests at high altitude. The other was shipped post haste to the plant of the L-W-F Engineering Company at College Point, where a modification of one of that company's production airplanes was being built to give the engine actual flight tests. Here another race against time had been under way. Design work on the modification of an airplane started at 8 o'clock on a Saturday morning, immediately after Donald Douglas arrived with complete information on the engine. Between that time and early the next afternoon, working continuously through the night, designers turned out every drawing that was necessary and the parts were actually under construction. It was only a matter of days before the experimental engine was installed in this airplane, complete and ready for flight, the first flight taking place at the L-W-F field at Central Park, Long Island, in August, 1917. It might be of interest to add that, shortly after this date, that old war horse ex-President Theodore Roosevelt made his one and only flight in this airplane. It is not generally known that these first experimental Liberty engines were eight-cylinder models. Since advices from the fighting front at about this time began to call for greater power, it was decided that the production engines would have to be increased in size. This was quite a

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jolt for the designers, but it was taken in stride. Many parts had already been tooled up for and production was getting under way; hence the simplest and quickest solution was to increase the number of cylinders—thus at least the cylinder assemblies and many other parts could be continued without change. This is how it happened that the production Liberty appeared as a 12-cylinder engine and even today only those who were connected with its development really know the story.

### *The Production "Scandals."*

The secrecy that necessarily surrounded production of war aircraft in general, and the Liberty engine in particular, soon made the public restless—all the more since the Aircraft Production Board was given to the policy of releasing ridiculously optimistic estimates of its expectations. Then, too, the matter of putting the aircraft production in the hands of automobile men had caused some resentment in the older section of the industry. It was not long before critics of the production program became very numerous and attacks upon the handling of the program became rampant. Charges were made that the production actually attained was only a small fraction of what had been promised and the Aircraft Production Board was accused by the press in general of gross incompetence; some publications even went so far as to charge certain of the members of the

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board with actual dishonesty. Although production did fall far behind expectations, it must be conceded in all justice that the Aircraft Production Board had been assigned a problem in the solution of which only a magician could have accomplished as much as the public expected. Wartime production did not come up to the impossibly high figures of advance promises and many mistakes really were made, but (in spite of all charges) this country *did* produce huge quantities of airplanes and engines. Considering how small the industry was to start with, it is an open question if more production could have been attained under different management. Perhaps the biggest error was in the airplane end—in leaning too heavily upon talent from the automobile industry on the theory that knowledge of production methods was more important than knowledge of aircraft. This criticism, of course, does not apply to engine production, in which the automobile industry performed wonders. As for the Liberty engine, regardless of all that has been said at the time and since, it really turned out to be a thoroughly good engine. The improvements that were made in it after the war came from experience that we did not have and could not have had when the original Liberties were built. Even its battery system of ignition (the adoption of which had been criticized) was retained until some time after the end of the war despite published reports to the contrary.

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### *The Real Production Figures.*

So many conflicting stories have been published concerning these activities that some of the actual production figures might be of interest. Here are a few, most of them taken from the official War Department statistical report that appeared in May, 1919: Primary-training airplanes started coming through in June, 1917; by the day of the armistice 5,300 had been delivered. Advanced-training airplanes reached quantity production early in 1918; by the armistice, 2,500 had been delivered. On the day of the armistice, deliveries of engines for training airplanes reached the total of 17,673 for all types. The De Havilland-4, selected as standard fighter type and redesigned for the Liberty engine, was being turned out at the unheard of rate of 1,100 per month; 3,227 had already been delivered; 1,885 had been shipped to France, and some were beginning to appear over the front lines to supersede the original foreign-built fighters. The total figure for all types of airplane and flying boat delivered during the war had reached 13,894 on the date of the armistice! And the Liberty engine that supposedly had been a fiasco in production was being turned out at the rate of more than 4,200 a month by October, 1918. By the day of the armistice a total of 13,574 Liberties had actually been turned out! And, so far as its being a "flop" is concerned, it is worth noting that several months after the armistice the British still thought

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enough of it to request that the United States continue its shipping of Liberty engines to England! In all, the United States built 41,953 aviation engines during the period of its participation in the war. And this production was necessarily in addition to the creation and operation of some thirty-five flying fields and schools and the training of about 10,000 pilots and nearly 200,000 enlisted men in the Air Service.

### *Almost Too Much Production!*

Thus, despite all its errors and blundering through, the United States did produce tremendous numbers of airplanes and engines in the First World War. The truth of this was appreciated only too well by the remnant of the industry that tried to continue after the war. For these firms, struggling to continue after the armistice, quickly found that they were being driven out of business by the competition of the Army and Navy, which were releasing (and gradually, at that) enormous numbers of war-surplus airplanes and engines. The Liberty engines—which a few sensational newspapers would have had us believe were never built—were produced in such quantities as to supply needs of the services for many years thereafter. Indeed, the same war-produced Liberty (with minor improvements) was still being used in *commercial* airplanes as much as a decade after the war. And as late as July 18, 1927, there came an announce-

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ment from the War Department that threw memories back to the hysterical charges of the wartime production scandals. This was a notice by the Air Service that on September 1, 1927—almost 9 years after the close of the war—the last of the war-built Curtiss JN-4 training airplanes was to be retired from use! Thus the wartime production was sufficient not only to swamp the industry when part was released as surplus after the armistice but also to meet much of the Army training needs for almost 9 years!

### *Where the Money Went.*

Long after the general public had forgotten the “aircraft scandals” the memory of them rankled in the minds of those in the industry and the injustice of most of the charges still called for contradiction. Hence, in April, 1921, Lester D. Gardner, publisher of *Aviation*, obtained from the War Department a statement of the actual expenditures. Charges broadcast in the war period had been centered around the theme song of a “billion dollars spent and no airplanes delivered.” The production figures we have just given above. The expenditures, as culled by Gardner from official reports, showed that exactly \$598,090,781 had been spent instead of the “billion and a half” so glibly recited earlier. And of this, only \$113,721,043 went for airplanes, \$244,838,162 for engines and \$7,149,283 for balloons and airships. The rest had gone into training pay and the main-

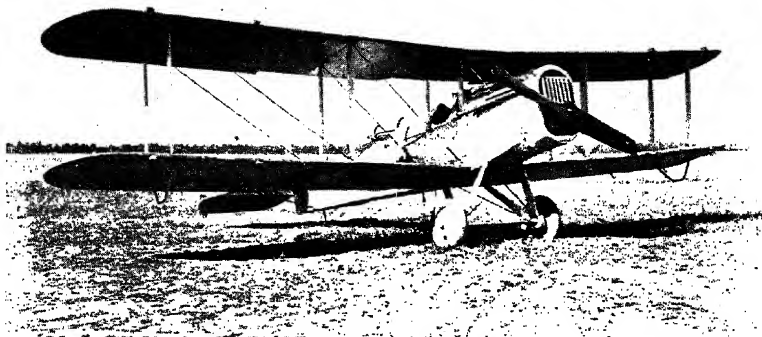


FIG. 31.—The American-built De Havilland-4 which figured highly in the sensational stories of wartime airplane production. (*Official photograph, United States Army Air Corps.*)

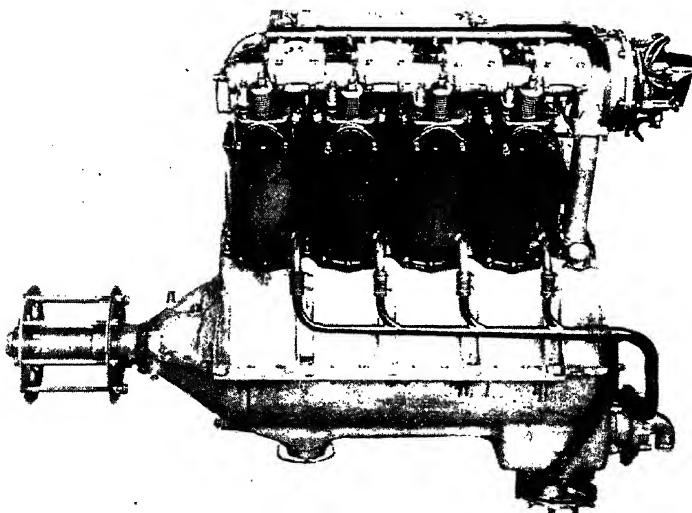


FIG. 32.—The original wartime Liberty was planned as an “eight.” Only two like this were built; then it went into production as a “twelve,” and 13,574 Liberty engines followed. It took the aviation industry almost the next decade to wear them out!



FIG. 33.—The “Mars,” Glenn L. Martin’s 70-ton flying boat, on its maiden flight.

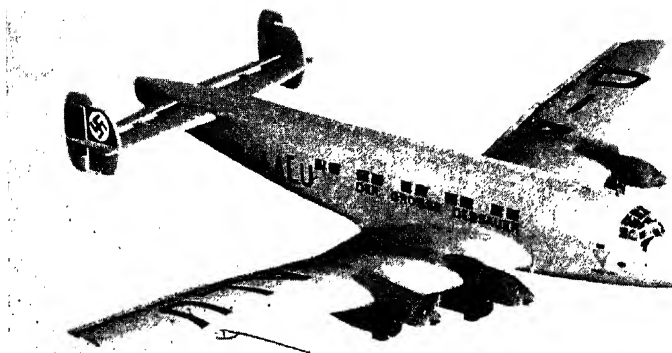


FIG. 34.—This Junkers Ju90 is a German version of a forty-passenger transport airplane. (Courtesy of Deutsche Lufthansa A. G.)

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tenance of air bases. These figures allow for deduction of the comparatively small sums realized from sales of surplus equipment after the war. All of the rest of the appropriations that figured so highly in the screaming headlines about "aircraft-production scandals" had never left the U.S. Treasury!

## Chapter XI

# Postwar Aviation High Lights

### *The First Atlantic Flights.*

FOLLOWING the First World War, with a turn toward civilian activities, the idea of a transatlantic flight was revived and it was not long before several attempts were made. We have already mentioned the original transatlantic airplane-flight project that was terminated when the war stopped construction of the boat then being built for Rodman Wanamaker. During the war, the U.S. Navy and the Curtiss Engineering Corporation had collaborated on the development of a type of very large flying boat that was designated as the "NC" series. Four of these were under construction at the Garden City plant and almost completed when the armistice was signed, whereupon the Navy decided to use them for an experimental Atlantic crossing. The NC's were large biplanes of about 126 feet in span, weighing 28,500 pounds, as loaded for the Atlantic flight, each powered by four Liberty engines. Each boat required a crew of five men. Most elaborate preparations were made for the crossing, since the Navy was undertaking the venture as a scientific project and wanted to

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risk no avoidable loss of life or equipment. Eventually the boats took off, the NC-1, NC-3 and NC-4 leaving Rockaway Naval Air Station under direction of Commander John H. Towers on May 8, 1919. Stopping at Trepassy Bay, Newfoundland, they left on the overocean hop to the Azores on the sixteenth. From there they were to continue to Lisbon and thence to Plymouth, but—as it finally turned out—only the NC-4 actually completed the entire trip; the others were forced down on the way.

In the meantime, various individuals were preparing to make the attempt in an effort to win a prize of \$50,000 posted by the London *Daily Mail* for a nonstop crossing. On May 18, Harry Hawker and Kenneth MacKenzie-Grieve took off from Newfoundland in an effort to win this prize, but they were forced down in mid-ocean. However, both men were saved by the crew of a Danish steamer. This first failure was soon followed by the flight of Captain John Alcock and Lieutenant Arthur Whitten Brown, who succeeded in making the flight to Ireland. Leaving Newfoundland on June 14, 1919, they landed at Clifden in Ireland on the morning of the next day. Although their airplane was badly damaged in landing, both men were unhurt and had the satisfaction of having completed the first nonstop flight across the Atlantic. Such is the fickle memory of the general public that many people have already forgotten the flight of the NC-4 and of Alcock and

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Brown—believing that Lindbergh made the first crossing.

### *Catapults Come Back.*

Among the many developments that showed progress in this postwar period was the power catapult for launching airplanes from ships. Earlier airplane-launching catapults had been used by the Wrights, but, as they adopted larger engines for their subsequent airplanes, they discarded this method of launching. The catapult appeared next in a different form and for a different purpose in 1911 when Captain W. I. Chambers of the U.S. Navy devised a power-operated catapult to launch an airplane from a warship. This first attempt was not successful, and it was November 12, 1912, before the first power-catapult launching was made by Lieutenant T. G. Ellyson, who took off from a barge in the Washington Navy Yard. Despite the fact that the First World War followed soon, nothing of consequence was accomplished in catapult development for a few years, although the British built and tested some catapults in 1916. However, in 1921 the U.S. Navy resumed its work on these devices and Lieutenant Commander Hamlet of the Coast Guard suggested the use of powder instead of the compressed air heretofore used to provide energy for accelerating the airplane. The plan was tried and proved to be most successful, its chief gain being in the saving of time that was

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formerly lost in recharging air tanks. This saving made it possible to launch a series of airplanes in rapid succession. The catapult came into its own and was adopted for Navy use. Years later (shortly before the Second World War) the Germans applied this system of catapult launching in the commercial field, by sending mailplanes from the decks of ocean liners as they neared the coast. Considerable time has been saved in this way in mail delivery.

### *The Warship Bombing Controversy.*

With the development of aerial bombing in the First World War a school of military thought appeared that contended that the possibility of attack from the air had seriously affected the value of the battleship in naval strategy. This claim was vigorously contested by the Navy authorities in all parts of the world, the controversy becoming most acute in the United States, where Brigadier General William E. Mitchell championed the airplane against the battleship. Indeed, if we may accept the statement of an administration official of that time, the freedom with which he spoke his mind "greatly annoyed the Navy." After much argument, conducted largely through the columns of the public press by amateur "experts," the matter came to a point at which military and naval authorities felt that it was time for a showdown. Accordingly, early in 1921, arrangements were made for joint Army and Navy tests

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of the efficacy of aerial bombing. Some of the captured German warships, and also the radio-controlled United States battleship *Iowa*, were designated as targets. The airplanes-versus-battleship tests excited tremendous interest among the general public as well as dividing military and naval experts into two rival camps. As Secretary of the Navy, the Honorable Josephus Daniels felt it incumbent upon himself to take up the cudgels for the Navy despite the fact that he was a former newspaper publisher with no previous naval or aviation experience. Indeed, not long before he had caused considerable amusement by issuing an edict to the Navy ordering that "left" and "right" be substituted for "port" and "star-board"—apparently he was having trouble in keeping the terms straight in his own mind! To show his contempt for the aiming ability of bombers Daniels offered to stand on the bridge of a ship and let them try to sink it! Rather fortunately for his own safety he did not press this rash offer. And one of the flyers had sufficient sense of humor to drop a bomb squarely on the bridge—his aim most obviously inspired by Daniels' remarks, since this shot had not been on the program.

### *The Bombing Tests.*

Included among the war craft scheduled to be bombed in these 1921 tests were a submarine, a destroyer and a cruiser. In the first test three Navy

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flying boats aimed three small bombs at the submarine, landing each within its "danger zone" but making no direct hits. Immediately they circled back and dropped nine more, of which two were direct hits. The bombing altitude, however, was only about 1,000 feet, thus raising a question of what might have happened had the planes been under fire, as in war. The submarine began to sink at once and was under water in about 6 minutes, thus giving the Army pilots no chance even to aim at it. Later in the series of tests the light cruiser *Frankfurt* was sunk after several attempts. The climax of the tests, however, came with the sinking of the former German *Ostfriesland*, which the builders had once boasted of as "unsinkable." This followed in the tests of July 20 and 21, Army flyers under the direction of General Mitchell himself beginning with their smaller bombs in order to determine the effective value of each size. Bomb dropping started with these smaller bombs on the twentieth, but no real damage resulted. The attack was resumed next morning and the bomb size increased until Mitchell's pilots were releasing their 1,100-pound "eggs." By noon they had placed five of these in the water *around the vessel*, the intent being to have them explode under water in order to drive in the plates of the ship. No attempt was made to obtain what would ordinarily be called "direct hits." Returning to their base, the planes loaded up with 2,000-pound bombs for the afternoon

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tests, but by the time they returned to the ship the “unsinkable *Ostfriesland*” was already showing the effects of the morning attack. A few of the large bombs were dropped, but these served only to hasten the finish and the doomed ship rolled over and sank. General Williams, the Army Chief of Ordnance, turning to a companion, remarked, “A bomb was fired today that will be heard around the world.”

This last sinking came as a tremendous shock to some who had been ridiculing the whole series of tests and, to provide a further check of the effectiveness of aerial bombings, a second series of tests was arranged for in 1923. Thus, on September 5 of that year, the obsolete United States battleships *Virginia* and *New Jersey* were sacrificed to this cause. Both ships were sunk by 1,100-pound bombs! The possibility of sinking by aerial bombing having thus been demonstrated, the Navy promptly took action to combat this menace by equipping its battleships with small fighting airplanes to drive off the bombers. Although the tests did not by any means end the utility of surface craft, as the more enthusiastic airplane advocates had contended would happen, they did convince all navies of the urgent necessity of providing for defense against aerial attack.

Events of years later, during the Second World War, have brought a more conclusive answer to this question of aircraft versus battleship—but more of that anon.

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### *Flying by "Foot Power."*

The earliest attempts at human flight were dependent upon the use of arms and legs to provide the motive power because there was no alternative source at that time. Rather surprisingly, it was several years after the World War before any experimenter met with the slightest encouragement in using man power and that experiment was only a brief demonstration. Even then, several years passed, with the records showing W. F. Gerhardt as the only man ever to support himself in the air with his own muscular effort. Gerhardt, who was then connected with the U. S. Army experimental station of McCook Field, Dayton, built a tiny 98-pound airplane with a foot-pedal-operated propeller and actually flew this contraption in 1923. He did not succeed in taking off with his own power but had first to be towed behind an automobile. Once in the air, he maintained himself in flight for a short distance by furiously pedaling. Experiments were continued with the backing of several Detroit businessmen, who advanced funds to carry on the work because of its scientific interest. A second machine was built, but financial difficulties intervened and some years later this craft was destroyed by fire. Subsequently Gerhardt turned his attention to the plan of building a man-powered helicopter and this was undertaken in the laboratories of Wayne University at Detroit. In June, 1938, this foot-powered helicopter was

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actually lifted from the ground by the vigorous pedaling of Mrs. Joanna de Tuscan, wife of the university's fencing coach. In the meantime, Enea Bossi, who had been experimenting also, succeeded in taking off a small man-powered airplane in 1937. This was the first time that any kind of aircraft had been lifted from the ground solely by muscular effort.

### *The Postwar "Gypsy Flyers."*

The end of the First World War brought a letdown to the aviation industry, which was followed by several years of hard struggle. Many large firms simply closed up shop and abandoned their efforts to remain in aviation. Any other policy became a matter of groping around for some civilian uses for airplanes—not from lack of ideas but from lack of faith on the part of businessmen. The war had made everyone think of aviation from a military point of view; peaceful uses were apparently inconceivable. It was in this period that the veteran flyer Dick Depew, when questioned about the hazards of flying, would reply that "the greatest hazard in flying is the risk of starving to death." The troubles of American manufacturers were intensified when various governments began "dumping" their war-surplus airplanes, but this was stopped (so far as foreign materials were concerned) by legal action based upon infringement of the Wright patents.

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Domestic surplus material still remained a problem even though the release covered a period of years. In one respect this cloud turned out to have a silver lining, for it enabled many ex war pilots to buy airplanes and start their own flying services with very little capital. Renting a cow pasture, such a pilot would begin with a discarded Curtiss JN-4d no longer required by the Army for training pilots and hence sold for a small percentage of its original cost. These "Jennies," as they were popularly known, formed the basis of many a one-man flying service carrying passengers on short hops for whatever the traffic would bear—usually \$3 to \$5 per person. When prospective business in the locality of the original cow pasture became worked out, the plane would be flown to some new territory; hence the title of "gypsy flyers" by which these pilots became known. After a couple of years it developed that some of them had found enough charter business and flying instruction to warrant putting up a hangar and settling down in one place. From this procedure an important business began to develop and a striking comparison resulted. In Europe, under the protecting wing of government subsidies, a synthetic type of air transport was growing that inspired Americans returning from abroad to provide glowing stories of how far ahead of us Europe was in aviation. In the United States the absence of these subsidies made a similar development impossible, although the Air

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Mail Service was actually running up more mileage than the European passenger routes. It turned out later that the "gypsy flyers" were adding even more to this.

### *"Fixed-base" Operations Follow.*

By the time that a number of the "gypsies" had settled down to fixed bases, they had built up a substantial volume of charter flying that, for want of a better name, became the "aerial taxi" business. About 1924 or 1925 this had grown to much greater proportions than even those in the industry realized. In the course of its compilation of statistics on the entire industry, the Aeronautical Chamber of Commerce rather casually decided to include some figures on these fixed-base flying operations. Reports were collected and no sooner had the organization started to add up mileages than it became suspicious of their accuracy. It seemed impossible to believe that so much flying could really be going on. For these figures showed that the much maligned and "backward" aviation industry of the United States was actually running up a total mileage far beyond that of the better organized and better publicized but government-supported air-transport systems of Europe. In 1924 the Chamber found fifty-seven operators reporting, not to mention the many others who did not bother to reply, since they were under no obligation to do so. At about this time Lester Gardner,

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publisher of *Aviation*, decided to do some investigation of his own. Using the opportunity afforded by the mailing list of his magazine, he broadcast a series of letters asking for information on flying activities, with the result that replies came back reporting 344 flying services actually operating! The mileage was even more remarkable. According to the records presumably substantiated by their log books, the 344 operators reported the startling total of 6,823,730 airplane miles for the year 1925! Even if it is assumed that exaggeration had crept into some reports, the total would still remain surprising—for the greatest airplane mileage officially recorded at that time was in France and this reached only 2,249,000 miles in about the same period. Subsequent years have shown that tremendous growth has continued in this type of flying; Government reports for the year 1938 showed the gigantic total of 129,359,095 airplane miles flown and 1,238,133 passengers carried for hire—these figures including all types of flying except air-line operations.

## *Chapter XII*

# Air Mail and Air Transport Begin

### *The First Air Mail.*

SEVERAL attempts to establish air-mail services followed the Ovington demonstration that we mentioned earlier. In 1912, the Postmaster General of the United States recommended to Congress that his department be given an appropriation for experimenting with airplanes in transporting mail, but the idea evidently seemed too visionary for Congress at that time and the request was not granted. Again, in 1916, the Post Office Department laid plans for experimental air-mail services, one to be in Massachusetts and some others in Alaska, the cost to be paid out of the general appropriations for mail transport. Advertisements were posted offering contracts for these services, but no bids were received. It was not until 1918 that actual progress was accomplished. In that year an appropriation of \$100,000 was made available for experimenting with mail airplanes and as a result the first regular civilian air-mail service in the world began on May 15, 1918. On that day Lieutenant George L. Boyle left Washington, bound

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for Philadelphia, and Lieutenant Torrey H. Webb took off from Hazelhurst Field (now a part of Roosevelt Field), Long Island, headed south. At Philadelphia, Lieutenant J. C. Edgerton relayed the mail south to Washington and Lieutenant H. P. Culver carried the northbound bags on to Long Island. Since no mail airplanes were available with which to begin service, Army equipment was borrowed and converted to postal use by the installation of a mail compartment in place of the front seat. The flying was done by Army pilots, but it was a truly civilian service, since it carried public mail cleared through the Post Office in the usual manner. The Army continued operation of the service until August 12 of the same year, when the Post Office took over the operation with its own staff of pilots and maintenance crews. The New York-Washington route was chosen solely for demonstration purposes, merely to show that mail could be carried in airplanes and service maintained with reasonable regularity. It never was intended to make the initial service permanent. Hence, its original function having been completed by the time that the transcontinental route had been opened, the New York-Washington service was discontinued on May 31, 1921.

### *Air-transport Services Begin.*

The beginning of present passenger air transport came in the next year, with the start of the first

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London-Paris services on August 25, 1919. Two firms began operation simultaneously, offering the first *airplane* passenger service—although not the very first air transport, since this honor went to the prewar Zeppelin routes in Germany. This inception of post-war air transport was followed by numerous efforts to develop a satisfactory type of transport airplane and a number of designs appeared, most of them being modifications of bombing airplanes. Handley Page and Vickers in England, Farman in France, and Glenn Martin in the United States were among those who made very creditable jobs of converting their wartime bombers into passenger transports in this period. The Curtiss Company, not having produced any bombers during the war, originated what was the first entirely commercial transport design in this country when it built its Eagle. Seriously hampered by the restrictions of the Versailles Treaty, Germany was unable to do much at first; as the limitations were lifted, however, she subsidized the development of internal air lines and soon was forging rapidly ahead in air transport. The first contract air-mail service in America was operated by Edward Hubbard between Seattle and Vancouver, starting on October 15, 1920. This was begun with a single Boeing flying boat which later served to give evidence of the reliability of aircraft; when it was retired from service some years later, it had flown

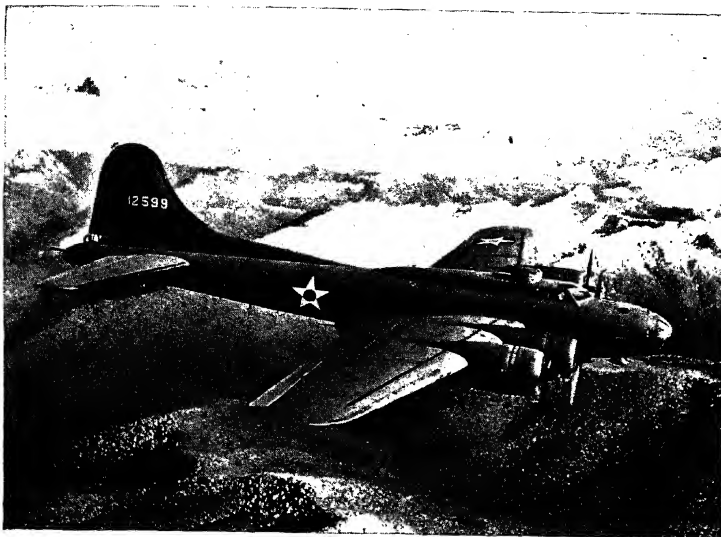


FIG. 35.—The Boeing B-17E Flying Fortress, a type that is proving its worth during the Second World War.



FIG. 36.—The Bell Airacuda, a U.S. Army fighter of the late thirties, was the first military airplane designed for multiple-cannon installation.  
(Official photographs, United States Army Air Corps.)

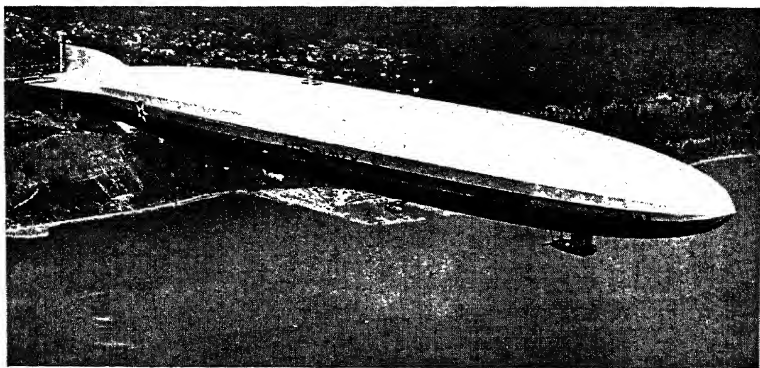


FIG. 37.—The Shenandoah was the first American rigid airship. (*Official photograph, United States Navy.*)

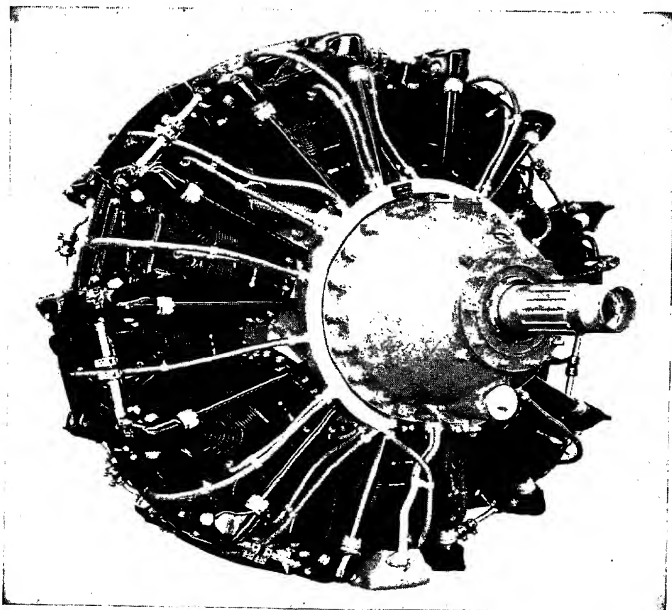


FIG. 38.—This Pratt & Whitney twin Wasp is rated to deliver 1,050 horsepower at flying altitude, and it weighs 1,413 pounds. Its maximum power at take-off is considerably greater. (*Courtesy of United Aircraft Corporation.*)

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350,000 miles. Hubbard's venture, incidentally, was William E. Boeing's first close contact with air transportation and it must have left a marked impression, for several years later he went into the air-transport business himself on a grand scale. But of that we shall say more in due time.

The first regular air passenger service in America began with the inauguration of the Aeromarine West Indies Airways service between Key West and Havana on November 1, 1920. This company, headed by Inglis M. Upperco of New York, used a fleet of several war-surplus F-5L flying boats, each equipped with two Liberty engines. These boats were completely reconstructed at the Aeromarine Plane and Motor Company's plant at Keyport, New Jersey, where passenger cabins were built into the hulls. The Aeromarine West Indies service was continued for about four winters, made an enviable record for safety, and was extended to include a summer line between New York and Atlantic City. However, the limited volume of traffic combined with the absence of a liberal mail contract or any form of subsidy forced the company to suspend operations in 1924. Although financially unsuccessful, the operation was a most important demonstration in the history of American air transport and as the first service of its kind it served to prove the utility and reliability of such services.

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### *First Transcontinental Air Mail.*

The original New York-Washington air-mail service of the Post Office Department having proven its reliability, plans were laid to create a transcontinental route. The first step toward operation of this new line was completed when the section between Cleveland and Chicago started flying on May 15, 1919. On July 1, the route was extended to New York, giving through service between that city and Chicago as well as advancing the delivery of transcontinental mail. On May 15, 1920, the route was operated through to Omaha and on September 8 the last section, between Omaha and San Francisco, began flying. Even though this service was flown only by day, it began by saving about 22 hours in transit of mail from coast to coast. The method of operation was to carry the mail by air between dawn and dusk. At night the bags were put on the train, where they continued on their way until next morning when, farther along on its way, the mail was again transferred to the air service. This transcontinental route immediately became the greatest commercial flying operation in the world, far exceeding the mileage flown by any European air services of the period. In addition, it was operated with such amazing regularity that it soon became the world standard in efficiency of airplane operations. For its time, the percentage of trips flown was almost unbelievably high. Through the entire year of 1921

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the service operated 92.84 per cent of its scheduled mileage and by 1923 this figure had been pushed up to 96.39 per cent of scheduled mileage. The creation of the original service and its extensions were directed by the Honorable Otto Praeger, then Second Assistant Postmaster General, who thus became known as "the father of air mail." By the time that this service had been operating for several months, it was evident that the fullest benefit would be realized only by night operation. Many skeptics arose to question the advisability of regular night flying. Of course, considerable night flying had been done in the First World War; it was in that period that landing flares were developed and shortly after the war, in 1919, the first aerial beacon had been installed at Hounslow, England. But wartime flying was another matter; in war exceptional risks were a part of daily routine and the pilots felt that night flying involved less risk than enemy fire.

### *Night-flying Demonstration.*

After carefully considering all sides of this project, it was decided to make a demonstration of the practicability of night flying, whereupon several of the mail pilots volunteered to participate. A through trip was scheduled to be flown, day and night, from San Francisco to New York on the twenty-second and twenty-third of February, 1921, and preparations were made for the attempt. This demonstration, it

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happened, came very close to being a total failure when bad weather interfered with plans on the section between Omaha and Chicago. Jack Knight—a rather appropriately named pilot—had been assigned to fly the first night section, which was the trip from North Platte to Omaha. According to schedule, he was to land at Omaha, where he would turn his plane over to a relay pilot, who was to fly it on to Chicago. The weather, which was none too good coming into Omaha, was so bad on the leg between Omaha and Chicago that the trip had actually been called off. The relay pilot appeared at the field and upon receiving this report went home, expecting that Knight would not get through. Everything indicated that this first night air-mail demonstration was about to become a complete “flop.” Knight, however, got into Omaha and landed, only to learn that he had apparently bucked bad weather to that point for nothing. Realizing how much the future of the air mail depended upon this one demonstration, he insisted upon taking the chance and making the trip on to Chicago despite the weather. So, taking on fuel, he hopped off again and with one more stop for gas at Iowa City, he arrived finally, safe and sound and more or less on schedule at the “windy city.” It was a dramatic flight, much of it through inky blackness pierced only by the flicker of bonfires lighted along the route by interested farmers and chambers of commerce. But the flight

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saved the demonstration from failure and as a result of its success Congress voted an appropriation to equip the first part of the transcontinental route for regular operation at night. And, as it developed later, this in turn blazed the way for night operation of commercial routes all over the world. The problem of equipment was attacked with great thoroughness. Emergency landing fields were cleared at comparatively short distances apart all along the airway; at these and at suitable locations between, flashing beacon lights were installed. At all airports the hangars were floodlighted and illumination of the landing areas provided. By the fall of 1923 this first night section was ready and the first regular night trip was made on August 22, 1923. Both because it would save the greatest amount of time and because the terrain involved less risk for night flying, the section between Cheyenne and Chicago was equipped first.

### *Night Flying Increases.*

For a time the service continued with only the central section being operated at night, an arrangement that saved considerable time as compared with the original scheme of bringing the craft all down at night. In the meantime, work was progressing on the preparation of the east and west ends of the airway and on July 1, 1924, the coast-to-coast mail went through all of the way by air, for the first time as the

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regular schedule. Night flying in the United States had not been in operation long before Europe began to take notice and the German Lufthansa system started its investigation of night flying in 1924. Britain and France also showed increased interest and some new lighting devices were being tried out on the London-Paris route by the end of 1925. Lighting of an airway, however, did not prove to be the ultimate solution, since "thick weather" blotted out the lights. The Bureau of Standards of the U.S. Department of Commerce began investigating the possibility of applying radio to guide the pilots both by day and by night in order to permit flying when poor visibility interfered with "contact flying"—this being the pilot's expression for flying by visible landmarks on the ground below. Work on the radio beacon was sufficiently advanced by 1925 to warrant its announcement in the trade journals of November 16, F. H. Dunmore of the bureau being given credit for its development.

Although landings were often made in the dark when "trips" came in late, the first regular commercial night-flying service outside the United States did not take place until Lufthansa began experimental operation of its Berlin-Danzig-Königsberg route in 1926. Over this line a total of 503 night trips were made in a period of 5 months. Night flying in Germany has since been continued and expanded and by 1938 that country had equipped about 3,000 miles

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of its air routes for night operation. In the meantime, the United States had embarked upon a huge program of airways development that, by the end of that year, had raised its total of night-flying-equipped routes to 23,723 miles exclusive of another 1,849 miles then under construction.

### *The Law Recognizes Flying.*

While these developments were going on, the law was beginning to recognize flying. Even during the First World War it became evident that extensive development of commercial flying and creation of international air routes would soon follow. Consequently, the effects of this came up for consideration while the peace treaties were still under negotiation and the Versailles Conference appointed an aeronautical commission to draft suitable international agreements. From this came the International Air Convention of October, 1919, providing an international law for civil flying but leaving each country free to enact appropriate statutes or otherwise to control flying within its own borders. Most countries soon followed with appropriate laws, but the United States delayed action until 1926, when the Air Commerce Act was passed. This put control of flying under the Department of Commerce and our first air-commerce regulations were promulgated by the Secretary of Commerce in 1928. Several years later the Civil Aeronautics Authority was created as a separate

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Federal body and in the fall of 1938 the duties of controlling and fostering the development of civil flying were turned over to this body by the Department of Commerce.

### *The Kelly Act Starts a Boom.*

Contrary to a prevalent impression, the initial boom in air transport in the United States resulted not from the Lindbergh flight but from several other and earlier happenings. Most important of these was the passage of the Kelly Air Mail Bill and the aviation boom was well under way long before Lindbergh even thought of attempting his flight. With the air mail functioning smoothly and night flying a proved success, the Post Office Department had reached the point where it was ready to turn the actual flying over to private enterprise, for it had no more desire to continue to fly its own airplanes than it wished to operate ships or trains. The way for this shift was paved by the passage of the Air Mail Bill, fathered in Congress by Representative Clyde Kelly. This bill authorized the Postmaster General to contract for carriage of mail by air at a rate not exceeding \$3 per pound. It became a law on February 2, 1925, and had a tremendous influence upon the development of air routes in the United States. Indeed, the entire air-transport industry of the country came into existence as a direct result of this act. One of the first evidences of what lay

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ahead came with the announcement, in May, 1925, of the organization of National Air Transport, Inc., the first really large-scale airplane-operating company in this country. The men chiefly responsible for planning this company were Howard Coffin, C. M. Keys, and Colonel Paul Henderson, the last-mentioned resigning his position as Second Assistant Postmaster General in charge of air mail in order to serve as general manager of the new company. The first mail routes offered under the Kelly Act were advertised on July 15, 1925, bids on eight routes being asked for opening on September 15. The first contracts were awarded shortly later and by the end of 1926 the Post Office had fourteen lines actually operating on air-mail contracts. This was the beginning of the great air-transport systems of the United States. The initial impetus given by the Kelly Act was then continued and extended by passage of the Watres Bill, which encouraged air lines to carry passengers as well as mail. The various operating companies now began extending their services to include transport of passengers as soon as they found their organizations functioning smoothly.

### *Air Transport Grows.*

In its first awards of air-mail contracts the Post Office did not include the transcontinental service; this it continued operating itself until 1927 in order to give the private operators a chance to show both

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their ability and stability. When bids for the transcontinental route were opened William E. Boeing, the airplane builder, showed up with a surprisingly low bid. Indeed, he was lower by such a margin that many other bidders shook their heads ominously and hinted that he would soon be ruined if he got the contract. Nevertheless, Boeing did get the contract for this section and within 5 months he had put twenty-five new and specially constructed mailplanes on the route. This operation he continued until it formed the nucleus of the great national system that became United Air Lines during the consolidation stage of a few years later. Around the same time many other consolidations took place, perhaps the most important being the creation of two other transcontinental systems: American Airlines and Transcontinental & Western Air.

While this air-mail development was going on, the air-postage rates were jumping "all over the map." For the original New York-Washington service the charge was at first 24 cents an ounce, including 10 cents for special delivery. Later this rate was reduced to 16 cents, still including special delivery, and still later to 6 cents without special delivery. Then the excess charge was dropped entirely and it was necessary only to mark letters "air mail." In 1924 the Post Office began again to experiment with surcharges and a zone system was adopted with charges that ranged from 8 to 24 cents

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an ounce. In 1925 and 1926 further changes were made on the basis of zones. Again in 1927, the rate was again revised to a flat rate of 10 cents a half ounce, regardless of distance, and again in 1928 this rate in turn was changed to 5 cents for the first ounce and 10 cents for each additional ounce. With the general change from 2 to 3 cents for ordinary first-class mail, which took place in 1932, the air rate became 8 and 13 cents and on July 1, 1934, the rate was once more revised to 6 cents for each ounce. At present there is some sentiment in favor of eliminating the surcharge entirely and there is a probability that such a plan will ultimately be adopted, although it may not be done immediately. In that case, however, all first-class mail moving over any long distance where there is an air route will be sent by air. This scheme has already been tried in many parts of the world; only the outbreak of war in 1939 prevented its continuance and extension, as will be shown later.

## Chapter XIII

# Lindbergh, Byrd and Chamberlin

### *The Orteig Prize.*

A CHAIN of events, destined to form one of the most amazing chapters in the entire history of aviation, began when Raymond Orteig, proprietor of the old Hotel Brevoort in New York, posted a prize of \$25,000 for the first nonstop flight in either direction between New York and Paris. The offer, announced in 1919, was to remain open for 5 years if it was not won in the meantime; later this time was extended. When first published, this offer was regarded in much the same light as the London *Daily Mail's* prize of \$5,000 for the first flight across the English Channel. Everyone, including many persons in the aviation industry, felt assured that the prize money would never change hands. After several years had passed without any serious effort to win it, attempts were made in rapid succession. The first try was made by René Fonck, French war ace, but Fonck's endeavor ended in a wreck with the loss of two members of his crew during the attempt to take off in September, 1926. In April, 1927, Lieutenant-Commander Noel Davis and Lieutenant Stanton Wooster,

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two American naval officers, were killed when they crashed during a preliminary test flight while preparing for another attempt to win the prize. Next came the loss of Charles Nungesser and François Coli, two French flyers who took off from Le Bourget on May 8 only to fall into the Atlantic. By this time many other contestants had appeared, none of them apparently in the least deterred by the fearful toll taken in previous efforts. In the United States, Lloyd Bertaud was preparing a Bellanca and Commander Richard E. Byrd was getting ready his big trimotored Fokker monoplane "America." Although it was not generally realized, Byrd's preparations were, by a large margin, the most thorough of those of all of the contestants and he took every precaution to avoid loss of life. Byrd, in fact, was almost the only one of this period who planned his attempt as a sane scientific venture instead of as a daredevil stunt.

### *Lindbergh Appears on the Scene.*

It was at this stage that a little-known former mail pilot by the name of Charles A. Lindbergh appeared as a new and rather late entry. This contestant showed his first sign of interest on January 21, 1927, when he wired the magazine *Aviation* asking for details of the terms of the Orteig Prize. Lindbergh had learned to fly only a few years before, had spent a short time in the Air Service and had started his real commercial flying as a pilot on the Robertson air-mail route in April, 1926. Being natu-

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rally adventurous, he soon acquired a name for taking chances that resulted in his being dubbed the "flying fool." His career in commercial aviation hampered by this reputation, he turned his thoughts to Orteig's offer. With the support of some St. Louis businessmen whom he interested in the venture, he ordered a Ryan M-1 monoplane of modified design to accommodate a huge gasoline tank for the transatlantic flight. So many others having the advantage of an earlier start, Lindbergh had no time to waste and the Ryan was completed in 60 days. Where Byrd chose to incorporate every conceivable precaution in his equipment, Lindbergh elected to gamble everything upon the reliability of his one engine. Stripping his craft of even the bare essentials, he decided against carrying a radio set by which a distress signal could be sent if he did have to land in mid-ocean. It was not to be a "commercialized flight," the young pilot told the reporters and, his hasty preparations completed, he hopped off from San Diego, flying through to New York after one stop at St. Louis. Arriving without any advance notice, he landed at Roosevelt Field in May, 1927. Until this moment the other contestants had paid little if any attention to Lindbergh and his flight from the coast thus came as a surprise. Somehow, a contestant out on the Pacific Coast who was still working on his airplane did not seem half so real as one who had just set the wheels of his craft down on the sod of Roosevelt Field after a hop across the continent. Even then the Byrd crew—still

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working with characteristic thoroughness on some last-minute load tests—exhibited only passing interest as the newcomer came in over the field at 10,000 feet and circled down to a landing.

### *Lindbergh Flies to Paris.*

His reputation as the “flying fool” seemed an appropriate one to most people when word got around that he was planning a transatlantic attempt with one engine and without even a radio. To his limited circle of friends he was still just “Slim.” Lindbergh kept pretty much to himself during the days of waiting for conditions that might seem to warrant the risk of starting. Eventually a weather bulletin indicated enough improvement to justify an attempt and he took off very early on the morning of Friday, May 20, the little craft having barely enough reserve power to “stagger off the ground” with its heavy load. Skipping over some wires by a margin of only a few feet, Lindbergh was on his way. An escort followed in the form of a press airplane, with photographers taking pictures that they probably thought would be the last ever taken of a fool-hardy pilot. The first part of Lindbergh’s flight was through weather so bad that at one time he actually turned back when sleet began to form on his wings. Encountering slightly better conditions, he changed his plans again and went on. The second part of the flight was through distinctly better weather, an important advantage, since it was in this part of the

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flight that visibility became the most necessary. Passing over Ireland and England, he crossed the Channel and by sunset on Saturday he was over northwestern France, following the airway beacons toward Paris. It was 10:24 P.M., Paris time (or 4:24, New York time) when he set the wheels of his Ryan down on the surface of Le Bourget and rolled to a stop, having completed his flight in 33 hours and 39 minutes.

What followed baffles description. When Lindbergh's foolhardy attempt turned into such an unexpectedly smooth-functioning success, the public became almost hysterical in its acclaim of the boyish young pilot. Such was the extent of this acclaim, that the United States government had to take cognizance of the flight and the United States cruiser *Memphis* was assigned to carry him home to a royal welcome here.

### *Byrd and Chamberlin Follow.*

The insane wave of enthusiasm that swept over the world centered itself exclusively on Lindbergh, completely ignoring the previous flight of Alcock and Brown and of the NC-4. Neither did it make allowance for the subsequent improvement in engines and airplanes that really made Lindbergh's flight less epoch-making than these earlier ones, despite the fact that only he flew *alone*. Even the amazing reliability of his engine was overlooked and when anyone brought up this question Lawrance, its



FIG. 39.—Pan American's marine base at Dinner Key, Florida, serves as a "jumping-off point" for Central and South America.



FIG. 40.—Small nonrigid airships like this are usually called "blimps." (Courtesy of Goodyear Tire & Rubber Co.)



FIG. 41.—Staff of the Civil Aeronautics Authority, in one of its Airways Division offices, keeping track of the movements of big airliners in their flight along airways.



FIG. 42.—Charting movements of airliners in an Airway Traffic Control Office—each block on the map represents the last-reported position of an airliner.  
(Photographs by Civil Aeronautics Authority.)

## LINDBERGH, BYRD AND CHAMBERLIN

designer, would counter with, "Who remembers the name of Paul Revere's horse?" Within a few months this rather apt comment had made its rounds of the entire aviation industry. Despite the fact that Lindbergh's flight removed the incentive so far as prize money was concerned, many of the rivals decided to go on with their plans. Clarence Chamberlin, with Charles A. Levine as the first transatlantic airplane passenger, followed on June 4, arriving at Helfta in Germany at midnight on Sunday, June 5. Originally they had intended to go right through to Berlin, but they were forced to make this stop for gasoline. A second landing was made in a marsh at Kottbus, where a broken propeller prevented further flight for the time being. Byrd and his crew, following on June 29, lost their way because of the very bad visibility and thus missed their mark when they had almost reached their destination. Byrd did not encounter the good fortune of Lindbergh, who had had clear weather when it was most needed; much of Byrd's flight was made through fog. The crew saw neither land nor water for about 19 hours and for the last 5 hours before landing they were completely lost. Finally, with their gasoline supply running low, they were forced to abandon further effort and a forced landing was made in the sea a few hundred feet offshore at Ver-sur-Mer in France. All the crew were saved and uninjured, paddling ashore by themselves in the inflatable rubber boat that had been taken for just such an emergency.

*A Mad Boom Ensues.*

What followed in the next two years seems almost incredible—even when viewed dispassionately and from the perspective of a decade and a half. In the United States a public that had given only passing thought to aviation suddenly awoke to the importance of the developments that had been going on under its nose for several years. The initial flights spurred others to similar efforts. Many of these ended in disaster but Amelia Earhart, Wilmer Stulz, and Louis Gordon made a successful crossing of the Atlantic in the airplane "Friendship" in June, 1928. The aviation business gained one enormous advantage from the publicity obtained by all of the flights, for it brought opportunities to obtain capital that was badly needed for expansion. Such was the rush to "get into aviation" financially that the actual capital needs of the industry were filled upon short notice and then there followed in 1928 and 1929 one of the wildest promotion campaigns in the history of American finance—strongly reminiscent of the earlier railroad booms. Within a short time, the industry had more capital—far more—than it knew what to do with. As a most natural and logical consequence, much of this new capital was wasted through utterly incompetent handling on the part of even some of the large firms. The bubble weakened about the middle of 1929, when it was fast becoming evident that the aviation business was sufficiently financed to take care of all possible needs for many

years to come. There was no early prospect of any reasonable return on the money that had been poured into it in the two years following the Lindbergh flight and even that money was being obviously mismanaged. With the first stock-market break in the fall of 1929 the bubble finally burst. Stocks that had been selling for enormously inflated prices dropped back to earth in the absence of buyers in 1929 and 1930. Before many more years had passed, however, some aviation stocks had reached a point where they were actually selling for less than earnings and prospects warranted. For, as it finally turned out, the aviation business was weathering the financial storm of America's greatest depression much better than some of the older industries. By the time that a general recovery in business had got under way a few years later, aviation enterprises were making a better showing than they had ever done before. With all its bad features, the wild boom of 1928 and 1929 had at least benefited American aviation in one respect. It brought in capital to finance expansion of air lines upon a basis that never would have been possible had the investors been more coldly calculating. Once established, there was too much at stake to abandon most of the routes thus started; hence expenses were pared and more energy put into going after business—with the result that some found it possible to show earnings. By 1939 most lines were showing profits and by 1941–1942 some had developed into first-rank industrial giants.

## Chapter XIV

# A Period of Varied Activity

### *The Renaissance of the Glider.*

THE several years just prior to and directly following these Atlantic flights proved to be a period of extremely varied activity. We earlier said that German aviation was restricted by the terms of the peace treaties for a few years after the First World War. This restriction caused a diversion of attention toward experiments with gliders or soaring airplanes, upon which almost nothing had been done since the advent of the power airplane. Some rather startling reports soon began to come out of Germany. As early as 1922, a flight of 1 hour's duration was made by the "Vampyr" at Wasserkuppe, but this was only the beginning of a series of glider exploits that soon amazed the world. Both the distance covered and the time in flight were increased with each succeeding year. By 1929, the "Wein" glider had established a record of 93 miles; about two years later the "Fafnir I" had pushed this up to 170 miles and by 1935 four pilots flew from Wasserkuppe to Brunn, about 310 miles, at an average of 40 miles an hour. Since then records of up to 465 miles have been made, all these flights being accomplished

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without the use of engines and solely by means of soaring. When the curtain of censorship is raised it may be found that even these records have been exceeded. This art of soaring depends entirely upon the principle of using the energy of air currents; hence areas selected for soaring meets are those in which the local topography favors upward currents that can be used in sustaining the craft. Originally, soaring pilots depended upon currents deflected upward by local hills; as they increased their experience they began, in about 1930 and 1931, to utilize "thermals" or upward air currents resulting from local temperature differences. Generally these thermal currents result from causes such as the rising of heat from the ground on warm afternoons. The publicity given to the German experiments aroused interest in other countries and around 1928 activity began in the United States, where some good records have since been made, although they have not equaled those of Germany. In 1941 the Germans utilized gliders extensively in the invasion of Crete—thus inspiring a sudden awakening, on the part of others, to the fact that gliders had some military possibilities.

In general design, gliders or soarers resemble airplanes except for their extreme lightness and their unusually high ratio of span to chord. As a natural outcome of the interest aroused by glider flights and the knowledge gained from them, a number of tiny airplanes appeared that were equipped with small engines. Some of these had engines delivering

as little as 32 horsepower. Although the extremely small airplanes never attained great popularity, those that followed, with from 50 to 75 horsepower, have been extensively used in training and in private flying.

*Rocket Flight Attempts.*

Rocket propulsion was another novel experiment that came in for renewed attention. Several inventors had conceived this idea, the first proposal probably having been Gerard's, in 1784. The first really scientific study of rockets was made by Professor Robert H. Goddard of Clark University, whose experiments extended over a period of more than twenty years. Goddard's experiments, although not made with the idea of airplane propulsion in mind, served as the starting point for further investigations and numerous jet-propulsion tests have since been made in wind tunnels. In the Goddard tests, rockets were sent up to heights of as much as 7,500 feet, attaining speeds of more than 500 miles an hour. The nearest approach to practical flight with a rocket airplane was made by the German automobile manufacturer Fritz von Opel, who built a rocket airplane and made short hops with it in 1929. On September 30 of that year Opel's little craft made its first flight, a hop of about a minute and a quarter, in which a height of 50 feet was reached. However, the flight was rather unsatisfactory for the reason that the field was too small to permit landing straight ahead and the craft was damaged in landing after

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making a turn in a space too small for this purpose. Fritz von Opel piloted the airplane, which was built much like a glider, with a span of about 30 feet and a short fuselage with rockets in the rear. Opel is reported to have made a speed of 120 miles an hour in a rocket-propelled automobile shortly before the flight of his rocket airplane.

In more recent years (1941-1942) stories about the Caproni-Campini airplane have been seeping through the Italian censorship. This unusual craft appears to be an airplane with a conventional engine driving a blower or propeller which sucks air into the front end of a huge duct in the fuselage and ejects it rearward. Although usually referred to as a "jet-propulsion airplane" it does not use a jet in the ordinary sense and nothing has been published about its efficiency.

Rocket flight, it should be noted, is one of those intriguing possibilities that have been very disappointing in the production of really tangible results. Many "successes" have been reported, but investigation has always shown the flights to be so short as to be most inconclusive. A tremendous amount of scientific investigation has gone into this development, but the meager results have somewhat dampened the ardor of investigators.

#### *Rockets Not So Promising.*

Inspired, perhaps, by Jules Verne's *Trip to the Moon*, the rocket-flight idea has had an especially strong appeal to the imaginative—but coldly scientific

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investigation finds little to bear out visions of flights in jet-propelled airplanes at great altitudes and over long distances. Until now, the efficiency attained with these devices has fallen far short of that already possible with engines and propellers and the outlook is distinctly discouraging. "Rocket motors" are very light for their power, but the efficiency of propulsion jets to date has been so poor that of the total energy of the fuel only two per cent could be usefully applied at around 90 to 100 miles an hour. Even the maximum so far is only about nine per cent at about 375 miles an hour. This ratio compares with that of engine-and-propeller combinations that already run around twenty to twenty-five per cent, and the continued increase in compression pressure of aviation engines (with its consequently greater efficiency) is pushing it still higher. One investigator has looked into the possibility of using the engine exhaust to provide additional power through application of jet-propulsion principles and this theory looks slightly more promising than the simple jet idea. Generally speaking, the rocket or jet-propulsion principle offers most promise under conditions of exceptionally high speed. As these speeds are approached the jet efficiency increases and the propeller efficiency falls off. It has been estimated that, if it were possible to build an airplane that could fly at more than 800 miles an hour, the rocket principle might then be promising. This speed, however, is yet too fantastic to be considered even as a future possibility, although it is always dangerous to say of anything in aviation that "it will never come."

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Whether or not the rocket or jet-propulsion idea will remain visionary may depend upon the application of some totally different principle in order to bring the efficiency of the jet up to a point at which it can compete with the propeller and engine.

### *The Guggenheim Safe-aircraft Competition.*

An interesting experiment in airplane construction resulted from the safe-aircraft competition initiated by the Daniel Guggenheim Fund for Promotion of Aeronautics, a first prize of \$100,000 and five others of \$10,000 each being posted in June, 1926, for an airplane capable of meeting certain very rigid conditions that had been set up for the purpose of furthering safety in flying. The competition attracted several entries and after all tests had been made the Curtiss Tanager, designed by Robert R. Osborn, was announced as winner in January, 1930. Among other things, this craft demonstrated its ability both to fly and to land under perfect control at unusually low speeds. The Tanager had nearly every conceivable gadget developed in aerodynamical laboratories up to that time, including a type of slotted wing upon which F. Handley Page, the British builder, promptly filed suit for infringement. Despite its remarkable performance, the Tanager type failed to "go over" with the flying fraternity and no others were built.

### *The Giant DOX.*

The year 1930 brought the huge Dornier DOX flying boat, which represented such an immense

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increase in size as to mark an entirely new era in large aircraft. Design work had been started in 1926, but the tremendous amount of study involved required so much time that the first flights were not actually made until February, 1930. Twelve air-cooled Siemens Jupiter geared engines were at first installed, but they did not develop sufficient power to meet requirements; whereupon the same number of Curtiss Conqueror water-cooled engines were substituted, this revised design being designated the "DOX-1a." Later, the DOX-2 was equipped with twelve Fiat A-22 geared engines, the respective weights of the three designs being 65,889 pounds, 68,780 pounds and 73,160 pounds, empty. The DOX-1a made a flight tour of North and South America between November, 1930 and November, 1932. As flown on that trip, the big boat developed a total of 7,400 horsepower; its total weight was 123,459 pounds, including a useful load of 54,675 pounds, and its maximum range without stopping for fuel was 1,988 miles. Although its size has since been exceeded by more recent craft, the DOX established an important place for itself in history as exhibiting one of the greatest increases in size over anything previously built. Indeed, it served to revise many previous conceptions of design limitations. While the DOX-1a was touring North and South America, a German builder brought out the first "stratosphere" airplane for operation at high altitudes, approaching the stratosphere level of the atmosphere. This was the Junkers JU-49, with a supercharged engine for maintenance of power at

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high altitudes and a body structure reinforced to allow the use of nearly normal air pressure in the cabin when the airplane was being flown at these altitudes.

### *The Metalclad Airship.*

We have previously made reference to the Schwarz all-metal airship of 1897 and its one flight; it was several years after the First World War before a second all-metal airship was built. This project began actively in 1922 when a group of men, most of them associated with the automobile industry, met in Detroit and organized an experimental group to work on all-metal airships, enlisting the cooperation of various interests, including General Motors Corporation, Henry Ford and the Aluminum Company of America. Carl B. Fritsche was elected president and Ralph Upson was made chief engineer of the organization, which was given the name of Aircraft Development Corporation. Much work lay ahead, the problem of assembling a sheet-metal hull being only one of the major difficulties. It was decided that riveting was the best method of fastening together the metal sheets; consequently the enormous number of rivets required made high-speed production riveting an obvious necessity. This need inspired the development of a most ingenious device: the automatic riveting or "rivet-stitching" machine. This machine is fed with wire from three coils; it cuts these wires into rivet lengths, punches the two sheets of metal, forces the wires into place and then heads each end to form the rivets. Three rows of rivets are

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driven simultaneously, the machine with 2 men doing as much work as 128 men could do in the same time by hand-riveting. Construction of this first modern all-metal airship was begun in 1928, the first rivet being driven in March of that year. By August 10, 1929, it was complete, inflated, ready for its test flight. This first test was made on August 19, 1929, and by September 12 the airship was being delivered at Lakehurst after a nonstop flight of 600 miles from the factory at Detroit. All tests were completed by September 16 and the ship accepted by the Navy. Over 10 years after its delivery, this airship was still in use, representing an unprecedentedly long life for any airship. It had a total volume of 202,000 cubic feet and its gross weight was 12,242 pounds, of which 9,115 pounds represented the empty weight and 3,127 pounds the useful load. Two Wright Whirlwind engines were used, supported by outriggers, one on each side of the metal control car. The hull was constructed of Alclad, a sheet consisting of duralumin (high-strength aluminum alloy) coated on each side with pure aluminum to improve its resistance to corrosion. The sheets were 0.0095 inch thick and the internal structure consisted of twelve narrow ring frames with twenty-four longitudinal girders.

### *A Distinctive Airship.*

The ZMC-2, as it was designated, was a distinctive airship in appearance as well as construction. Its

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diameter of nearly 53 feet and its length of only a little over 149 feet gave it a "stubbiness" in comparison with other airships. These proportions were necessitated by special considerations that came with the use of metal for the hull. The ship could have been made longer and slimmer, but its structure could not then have been so economically designed from the weight viewpoint. The Aircraft Development Corporation had originally planned to follow this with the design of some commercial airships ranging up to as much as 7,000,000 cubic feet in capacity, but the depression caused these plans to be shelved. In the meantime, the development of the large airplane and flying boat has gone ahead so rapidly that these types now seem to have taken over much of the field that was formerly considered exclusively that of the airship. On the other hand, airship builders still claim lower operating costs for very long-range transport and there is just a possibility that the airship may eventually be found to have its own field in long-range operations. As the years pass, however, this hope seems to be fading. Airships may offer some promise as carriers of small fast airplanes and a scientific committee appointed by the National Academy of Sciences, a few years ago, reported favorably on continuance of airship development, even to the extent of definite recommendation of construction of a large all-metal airship.

## Chapter XV

# The Story of Engines and Propellers

### *Early Aircraft Engines.*

THE development of aircraft engines, which took place through the years parallel with the advances in the craft themselves, might well be made to form the subject matter of a complete book. The problem here becomes one of condensing this part of our story enough to permit its being compressed into the confines of a single chapter. As we noted in our early history of flying, attention was first turned toward the steam engine, since this was the only practicable source of power available at that time. Indeed, it was not until the advent of steam as a source of power that plans for mechanical flight began to assume the least semblance of promise. Until that time the inventor had always been brought squarely up against an insurmountable barrier in the lack of power. Hence it was only logical that Cayley, Henson and others should turn first to steam, as was noted earlier. Then, in 1848, the Stringfellow model previously described flew long enough to

show that herein lay a possible answer to the problem of power. By 1894 Maxim had demonstrated that his steam-engined monster could lift enough to crash its way even through a guard rail intended to hold it down. Clement Ader's Avion and Langley's later models were also steam-powered. It was at just about this stage in aviation history that the internal-combustion engine was coming into its own as a promising source of power for the new "horseless carriages." Since it brought with it the expectation of still less engine weight, aerial experimenters took it up avidly and abandoned their flirtation with steam in favor of this newer source of power.

*The Langley, Wright and Other Engines.*

Thus it came about that the Langley-Manly engine, described in our recital of their experiments, was of the gasoline spark-ignition type. As also observed, by 1904 this remarkable five-cylinder radial water-cooled engine had been brought to the point where it developed over 52 horsepower, although its weight was only around 207 pounds complete with its cooling water. Like Langley, the Wrights decided upon gasoline as more promising than steam and at first tried to purchase such an engine. It was with great reluctance that they started to build their own engine when they found none sufficiently light already on the market and learned that no builder of engines could be induced to show the

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least interest in their specifications. The Wright engine of 1903 was a four-cylinder horizontal water-cooled type that lay flat upon the lower wing of their airplane. It delivered about 12 horsepower and weighed around 170 pounds without its cooling water. In the design of their second engine, the Wrights changed the position of the cylinders to a vertical one and the power plant used in their subsequent airplanes thus somewhat resembled automobile engines of the period. This second engine delivered about 35 horsepower and weighed some 180 pounds. It proved so reliable that it was made standard equipment of the historic Model B series of Wright airplanes and it soon earned a most enviable reputation. Following this, the world witnessed an epidemic of gasoline engines designed for use in airplanes, most of them being "homemade" products of the airplane builders. By 1909 several European engines had established reputations, including the French water-cooled Antoinette and the radial Anzani. By winning the Gordon Bennett Trophy in 1909 Glenn Curtiss suddenly leaped into prominence as a builder of engines also and his eight-cylinder V-type 50-horsepower 250-pound water-cooled OX engines soon found their way into other airplanes. At about this time there appeared the revolving, radial-cylinder, air-cooled Gnome, which established itself so well that for a few years it reigned almost supreme as the standard by which other aviation engines were

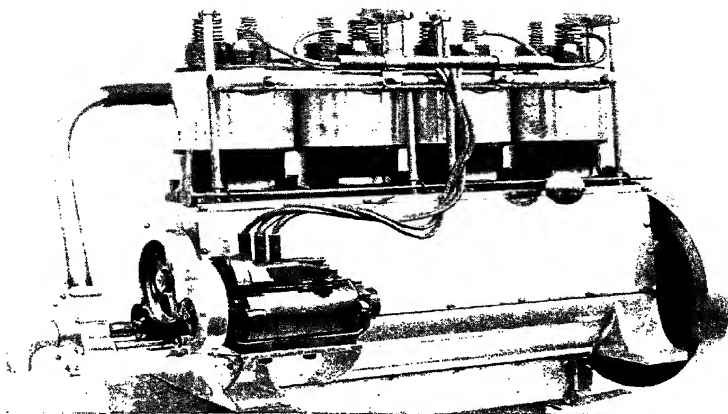


FIG. 43.—Although rated at 35 horsepower—nearly three times that of their first engine—this second Wright motor weighed only 10 pounds more. (*Courtesy of Orville Wright.*)

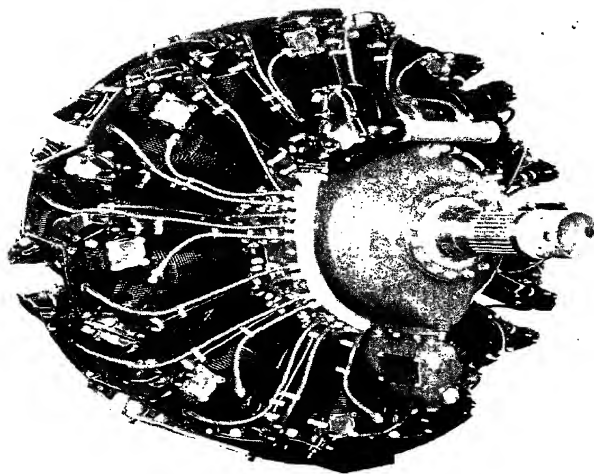


FIG. 44.—A striking contrast is formed by this recent Wright Duplex-Cyclone which delivers around 2,000 horsepower and is one of the most powerful engines of its kind. Lindbergh's 220-horsepower Whirlwind was a predecessor of this big engine. (*Courtesy of Wright Aeronautical Corporation.*)



FIG. 45.—The main Administration Building at New York's North Beach Airport (La Guardia Field). (Courtesy of U.S. Works Progress Administration.)

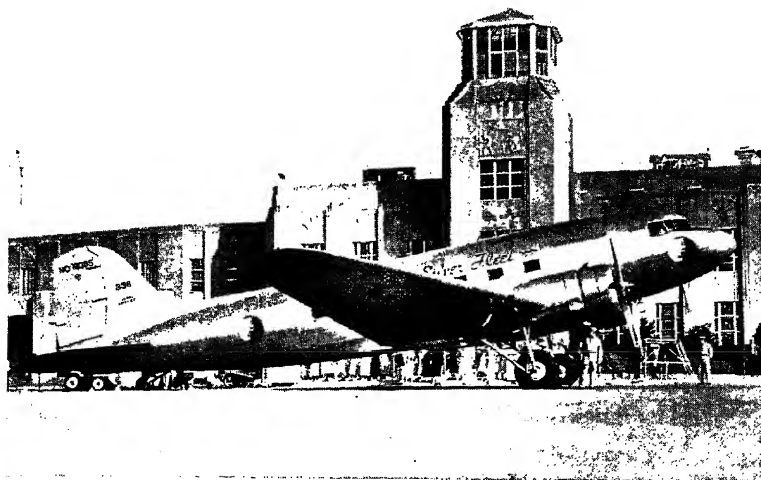


FIG. 46.—One of Eastern Air Lines' Great Silver Fleet in front of the striking Administration Building at New Orleans Airport.

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judged. This engine was first built as a five-cylinder type delivering about 34 horsepower and weighing about 132 pounds; larger units came later.

### *The "Rochester Gnome" and Others.*

From about 1910 to 1914 engine design was still somewhat formative and almost every conceivable type was represented—including many radical departures such as those with revolving radial cylinders (such as the Gnome) and others with revolving cylinders parallel to the crankshaft. Among other things, opening of the aviation market inspired a strong drive to capture this field for the two-stroke-cycle type because of the seeming promise that this type gave of lower weight as well as reduced initial cost—the latter a factor of importance to the struggling inventors who made up the greater number of airplane builders before the First World War. In the United States, this two-stroke-cycle "push" was especially noticeable. Several builders of small marine engines entered the field and the series of Elbridge engines became so popular among individual constructors that this make came to be known as the "Rochester Gnome," after the home city of its builders and the name of the original, but much more expensive, Gnome that still ruled the higher priced field. However, increasing refinement in engine design combined with the lower fuel consumption of the four-stroke-cycle type to displace

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the two-stroke-cycle engines by around 1914. Military officials, of course, never did give the latter type much support, since they were more concerned with performance than with initial cost. With the start of the First World War, airplane-engine production entered upon a phase of new importance. In rapid succession newer and improved models appeared in all the warring countries.

### *The Birth of the Liberty Engine.*

Under the driving force of military necessity development was rapid and constant; engines were designed, tested and ordered into production only to become obsolescent almost as they reached the front. When the United States entered the war in 1917, it was called upon to face a problem of engine and airplane production never before paralleled in other fields; the story of the scandals that this production involved has already been recited. Standardization of design became imperative, but it was equally necessary that the design thus standardized be suited to American production equipment and methods. The outcome was a daring decision, previously described, to develop a completely new engine using, so far as practicable, only those features that had been most successful in existing engines. Under tremendous pressure from all sides and with the full knowledge that success or failure in the war might depend upon the outcome of this undertaking

the historic Liberty engine was developed. Originally an eight-cylinder water-cooled sharp-V type, developments at the front that called for increased power necessitated the change from eight to the twelve cylinders before the smaller engine could be put into production. The Liberty-12, as produced in quantities, delivered 420 horsepower and weighed 844 pounds, or about 2 pounds per horsepower, thus marking another important advance in engine design.

*Subsequent Aviation Engines.*

Since those hectic war days, the development of aircraft engines has continued as one almost uninterrupted series of minor improvements and increases in size. Step by step, weight per horsepower has been brought down and unit output of engines has been increased until the present-day engine looms like a giant beside these engines of the latter days of the First World War. Outstanding groups of modern engines, making a list far too long to recite in detail, include the German Junkers and BMW; Italian Fiat and Isotta-Fraschini; French Renault and Hispano-Suiza (now rather incongruously named, for it is French built); the British Rolls-Royce, Bristol and Napier; American Pratt & Whitney, Curtiss-Wright, Allison and many others, these names generally representing not single engines but a whole series of models. Both liquid-cooled and air-cooled types are now represented, the former

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generally being of the cylinders-in-line type using one, two, three or even four banks. A few are engines of the Diesel type or a modification of it. The air-cooled engines are generally of the fixed-radial-cylinder type, with two rows of cylinders in the case of the larger models. Today we have proved engines that develop more than 2,500 horsepower and still larger units are under development. Some of these modern engines now weigh only about 1 pound per horsepower. Yet we once thought of the original Wright as a "very light engine"—for it weighed only 14 pounds to the horsepower!

### *The Propeller Story.*

Along with all this improvement in airships and airplanes and their engines, there went a somewhat parallel development of the aerial propeller—which also forms a history in itself. Propellers have been constructed of almost every conceivable material. Among earliest experiments were efforts to build propellers by the use of frames of bamboo or wood, upon which fabric was stretched to provide a surface. The first really practical aircraft propellers, however, were made of solid wood. Indeed, wood held the center of the stage for a long time, propellers being built usually of several laminations glued together, carefully shaped, sandpapered and varnished. Numerous efforts were made to find materials less subject to injury from mechanical causes, sunlight, moisture

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and (in the case of seaplanes) from water spray. Experimental propellers have been built of Micarta with fabric reinforcing, this material being a phenol (carbolic acid) resin similar to Bakelite. They have also been made of wood compositions. Others have been constructed of thin sheet steel welded together to form hollow blades and still others have been made of solid steel and in recent years of solid aluminum alloys. In the earlier days we even had one example of a propeller (used on one of the Parseval airships) that was made of cloth weighted at the ends so that centrifugal force held it out taut while it was rotating. Of the various types of material, only the laminated wood and the aluminum alloys have had any real vogue, the wood type coming in first but being generally superseded in more recent years by the metal. Most of the early propellers were just "made," without being scientifically designed. When the Wright brothers came to the question of a propeller for their first airplane, they headed for the Dayton Public Library and consulted some books upon the design of marine propellers—expecting to find in them the necessary information and believing that they could apply it to the design of their airplane propeller by merely allowing for the relatively lower density of air.

### *Marine Experience of No Help.*

To their amazement they found that marine propellers, with nearly three-quarters of a century

of experience behind them, were still being designed by cut-and-try methods and past experience. Temporarily stumped by this finding, they thought it out and eventually decided that an aerial propeller was just a wing that moved in a circle instead of along a straight line. Although the principle was not quite so simple as this conclusion would imply, they found that they could calculate the power required and the thrust generated by considering their propeller to be made up of a series of small wing sections, differing only in their distance from the center and the thickness required for strength. The result was a propeller quite different from most of those previously used. Much of the Wrights' initial success can be attributed to the efficient design of their original propellers, for their first engine was so small that it provided very little margin of reserve. A propeller much less efficient would most probably have made their first flight impossible. Many years passed before any really radical improvement was made in the wooden type of propeller, although its efficiency was further raised by refinement in design.

#### *The First Metal Propellers.*

It was some years after the First World War before any experimental types really "took hold." The first to attain any substantial vogue was Sylvanus A. Reed's metal propeller. This was made of flat sheet-aluminum alloy twisted to shape and its blades

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were semiflexible while they were at rest—the inventor depending largely upon centrifugal force to hold them against the thrust force while they were revolving. The Reed propeller came into general use in the United States and continued thus for several years, becoming displaced only when the makers of solid aluminum alloy propellers began building a type with blades that could be adjusted to different angles to suit varied operating conditions. These, however, were entirely different from the blades in the adjustable type in use today. Their adjustment was distinctly a ground job and the angle could not be altered while the craft was in flight. Nevertheless, these solid metal propellers soon began to displace the Reed; within a few years they were also provided with a mechanism by which the angle of the blades could be adjusted in flight. This improvement tremendously increased the value of the adjustable feature, for with a blade setting that could be changed in flight it became possible to obtain the best angle for climbing, high speed or cruising, as might be necessary for the needs of the moment. This innovation marked the beginning of the end for all other types of propeller except for little airplanes, in which case cost became the governing factor. To clinch matters further, the builders of these adjustable propellers followed up their successes by perfecting further improvements in rapid succession. First came “constant-speed” propellers,

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which automatically maintained themselves at the correct angle required to allow the engine to develop its power most efficiently under every condition of flying. These were quickly followed by "full-feathering" propellers, the blades of which could be turned "edge on" to the air while the airplane was in flight, in order to decrease resistance when the craft was gliding with the engines cut out or when it was being flown with one engine dead and the others running in a multiengined airplane. A recent development is the Wickwire-Spencer propeller, which adjusts its pitch automatically without the use of external mechanism or controls.

### *Reversible Propellers.*

From making a propeller adjustable in flight, it was a small and almost obvious step to make it adjustable over such a large angle that it could even be reversed in order to produce resistance instead of a forward push or pull. This extension of the adjustable-propeller idea came in 1938 when Ratier in France and Curtiss in the United States announced their reversible propellers. Reversing a propeller has several advantages in operation. Turning on the ground is greatly facilitated for large multiengined airplanes, since one propeller can be reversed while the other is running normally—thus the full engine power may be used for turning the airplane. Then, in making a landing, propellers

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can be reversed as soon as the wheels touch the ground, hence decreasing the landing run more effectively than is possible by the use of brakes alone and eliminating the danger of nosing over that might follow excessive use of wheel brakes for the same purpose. It has been a long trail from the simple wooden propeller of the Wrights' first airplane to the finely machined solid-metal blades of today—with a complex mechanism for adjusting the angle housed in the limits of a hub that is not very much larger than the old wooden ones.

## Chapter XVI

# Rotary Wings at Last!

### *An Old Idea Takes a New Form.*

THE rotating-wing or helicopter type of aircraft was one of the first conceptions of a flying machine; indeed, as has already been mentioned, this idea was originally conceived by Leonardo da Vinci in the fifteenth century. Although several centuries have elapsed and innumerable attempts have been made to build a practical helicopter, it is only within recent years that success has been attained. Development of the airplane put new life into helicopter efforts and in even the earliest days of airplanes several fruitless attempts were made to build helicopters. After the First World War designers renewed efforts to solve this problem, which, even at that late date, still remained baffling. The Petroczy-Karman in 1918, the Berliner and Oehmichen designs in 1920, the Pateras-Pescara in 1921, the De Bothezat in 1922, and the Curtiss-Bleecker a few years later were some of the valiant efforts—constructed at considerable expenditure of time and money with only indifferent results. Rather surprisingly, the first success in the rotating-wing field came in a very roundabout way. A Spaniard by the name of Juan de la Cierva, who had been experimenting with gliders in 1911, became tremendously impressed by

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the serious results that followed from "stalling," or inclining the wings at an excessive angle. This interest set him searching for some type of aircraft that did not depend so absolutely upon forward motion for its safety and control and, in 1919, he conceived the idea of the autogiro or "windmill" airplane. This type has a rotating wing that is maintained in motion by the movement of the craft. Illustrating a most ingenious idea, it differs as much from the conventional airplane as from the helicopter, yet it partakes of some of the characteristics of each.

### *The Autogiro.*

In its original form, of which much is retained in even the latest types, the autogiro consisted of an airplane fuselage with a vertical post carrying a rotating wing with narrow blades suggesting the blades of a propeller. In normal use this wing rotates of itself instead of being driven by the engine, as with a helicopter, although some later autogiros are modified helicopters, since a part of the engine power can be applied to rotation of their wings. The movement of an autogiro wing is a form of autorotation resulting from the resistance of its blades to the movement of the whole craft and this autorotation produces on its blades a lifting force that supports the craft. An engine with a propeller supplies the energy for rotation when climbing or flying level;

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when the machine is gliding or descending vertically, the force of gravity serves instead. In normal flight the autogiro is driven by a conventional engine-and-propeller combination and in many respects it behaves like an airplane with the usual fixed wings. Earlier autogiros required a run across the field to get their rotors revolving before they could take off, but, as mentioned above, the newer types have means for applying some of the engine power to start the rotor. These means are taken advantage of to make a "jump start." The blades are first set to a minimum angle while the rotor is being spun up to fairly high speed by use of the engine; in the meantime, the craft remains in one spot on the ground. When the required rotor momentum has been attained, the blades are quickly reset to a substantial angle; whereupon a powerful lifting force is created that makes the whole craft literally jump off the ground. Once the autogiro is in the air, flight continues much as with earlier types. One of the most important advantages of the modern autogiro is the fact that it can be flown as slowly as desired without danger of stalling and, with a slight wind, it can even be made to hover over one spot. As a consequence, it can be taken off from or landed within a very small area.

To make his wing system practicable, Cierva had to use an innovation that, some years later, pointed the way to the successful helicopter. This innovation is the *hinged* and *flexible* rotating wing, the narrow propellerlike blades of which are not rigidly secured

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to their vertical shaft but have a hinged connection and are held outward by centrifugal force. In addition, they have sufficient flexibility automatically to adjust their angle to suit their speed with relation to the air as they rotate. This adjustable feature is of the utmost importance. Without it, the blades meeting air at high speed (through moving against it in the forward portion of their circuit) would lift much more than those on the other side that are then moving backward and thus moving in the same direction as the air. Ordinarily this difference would result in seriously unbalanced forces when a revolving-wing aircraft was in forward flight. Cierva solved this problem with his flexible blade. Other inventors have built craft incorporating many variations of the general principle originated by Cierva. One of these is the Herrick convertible type, which has a rotating wing that can be locked in position. This type can be taken off the ground as an airplane and, once in flight, the wing can be released and allowed to autorotate to permit hovering or very slow landing. Another variation is designed to permit folding back of the wings and has a drive connected to the wheels so that it can be operated as a road vehicle when necessary.

### *The First Successful Helicopter.*

Although several earlier helicopters had made short hops, it was not until 1937 that the world

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saw the first really successful craft of this type. The final achievement was the work of Dr. Heinrich Focke, whose helicopter was flown in Germany in 1937 and 1938, demonstrating its ability to operate under complete control. Focke borrowed from Cierva the principle of the flexible rotating wing, but he also incorporated one more feature that seems to have become the last link that was needed to make the helicopter practicable. This is a mechanism for controlling the angle of the wing blades at any point in their rotation. It was invented in Germany in 1926 by Walter Rieseler and Walter Kreiser, who came to the United States and here developed their "feathering" control in collaboration with E. Burke Wilford in 1928 to 1932. By its use, the lift can be varied on either side, back or front, at the will of the pilot. This may not sound like a revolutionary improvement, yet it seems to have accomplished the difference between success and failure. All earlier helicopters that got off the ground at all—and some never got that far—made only short hops because they proved themselves so tricky and temperamental or so completely uncontrollable that they could not be safely flown. The pilot had such excellent control over a Focke helicopter that a series of demonstrations were staged in the Deutschlander Halle in Berlin in 1938. In this large auditorium, the Focke was repeatedly taken off the floor under its own power, flown to

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the other end of the hall, turned in the air, flown back to the starting point and gently landed back on the floor again—all at the will of its pilot. This successful demonstration, coming after so many years of disappointments, startled the aeronautical world. At about the same time the Bleriot Company built a helicopter in France, but it did not show control equal to that of the Focke. It is yet too early completely to size up its possibilities, but there is no doubt that much will result from the Focke development. This does not mean that the helicopter is likely to supplant the airplane—the probability is that each will find its own special sphere of usefulness. The helicopter would seem to have certain valuable characteristics that fit it for a type of work that the airplane cannot handle. Its ability to maintain a fixed position in flight should make it valuable in photographic work, military observation and many other uses for which ability to stay in one place is important. In addition, the ability of the helicopter to rise vertically and to descend vertically fits it for mid-city landings because it can be taken off from or landed upon any reasonably large flat roof.

### *Landing on Roofs.*

For years we have heard of visionary plans to land airplanes on the roofs of city buildings and an inkling of what is ahead for rotating wings was given by a demonstration made in Philadelphia in May,

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1935. There Jim Ray in a Pitcairn and Lou Levy in a Kellett autogiro landed directly on the roof of the post office to deliver a load of air mail right in the middle of the city. As the first outcome of this demonstration, an experimental contract was awarded by the Post Office Department in 1939, providing for transport of mail between the roof of the Philadelphia Post Office and an outlying airport. Service under this contract was begun in July, 1939, by Eastern Air Lines, using autogiros, but either the autogiro or the helicopter would be suitable for the purpose. Indeed, there is a tendency for the autogiro to approach the helicopter in development and it is quite conceivable that the line of distinction between the two may almost disappear at some time in the future.

### *The Sikorsky Helicopter.*

The Sikorsky helicopter made its first public flight on May 20, 1942. This craft represented a radical departure from most previous helicopters. It utilizes one large three-bladed rotor, 28 feet in diameter, to provide the lifting effort. At the tail of its fuselage there is a smaller rotor, more like a conventional two-bladed propeller, which revolves in a vertical plane and serves to compensate for the torque of the main rotor as well as to provide directional stability. This helicopter made a number of very successful flights during which it proved to have amazing controllability.

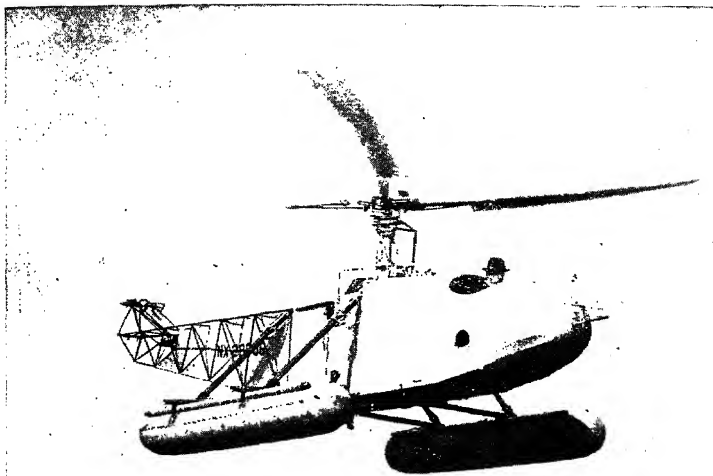


FIG. 47.—The Vought-Sikorsky helicopter in flight with Igor L. Sikorsky at the controls.



FIG. 48.—Later autogiros like this Pitcairn have dispensed with even the small fixed wings that were used on earlier types.



FIG. 49.—Modernism is generally favored by the architects of airport buildings, as is shown by the Administration Building at the Paris airport of Le Bourget. (*Courtesy of Air France.*)

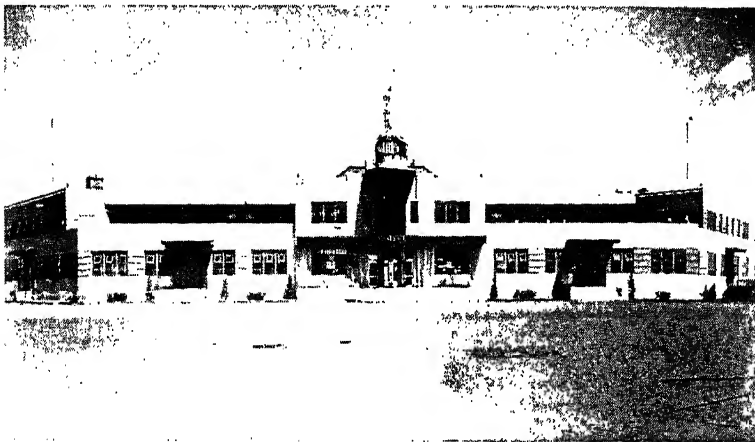


FIG. 50.—Newark Airport's Administration Building is an excellent example of municipal enterprise. (*Courtesy of Public Relations Department, City of Newark, New Jersey.*)

## Chapter XVII

# Airports, Airways and Radio

### *The Development of Airports.*

THE first airplane "landing field" was merely a part of the sand dunes at Kitty Hawk that the Wrights had selected for their experimental grounds; it was 1910 to 1914 before specially created and equipped flying fields came into existence. The areas used for flying in the meantime were simply cow pastures that happened to be sufficiently level for this purpose. By 1910 or so, a considerable amount of flying was being done from such places as the infields of race tracks and it was at about this time that the first specially prepared areas came into use. In those days 75 or 100 acres was considered enough; if the flying field had one or two wooden sheds capable of housing airplanes it was considered equipped. The word "airport" had not yet come into use and was not adopted until the well-equipped fields were developed during and after the First World War. Today the designation "airport" implies more than a level, cleared and well-drained field; an airport must also have modern hangars, repair shops, a restaurant, passenger buildings, night-flying and radio equip-

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ment, adequate ground transportation and the various other facilities that are necessary for regular flying. The term "flying field" still continues in use, but now it is generally applied only to that portion of the airport that is used for landing and take-off. Sometimes it is also applied to a cleared field that is used for occasional flying and does not warrant the title of airport. With the development of civil aviation, the traffic at airports has tremendously increased and with the heavy modern wing loadings the area required for operations has also increased. Between the two factors, airports have undergone so much growth that the sizes of earlier days now seem ridiculously inadequate. As compared with the 75 or 100 acres of pioneer times, we now expect to find at least 300 to 400 acres if it is a first-class airport; many of the important ones have as much as 750 and some more than 1,000 acres. The landing areas that formerly were grass plots now have paved runways 3,000 to 4,000 feet long and some airports have runways of nearly 7,000 feet.

### *How Airways Began.*

In our story of the U.S. Air Mail Service, we told how the inception of lighted airways resulted from a decision to fly the mails at night, how emergency landing fields were constructed along the airways and how a chain of flashing beacons was installed to guide the pilots along their course. Later, when radio beacons were developed, the lights were

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supplemented or even supplanted by radio. Present airway planning in the United States usually provides for emergency landing fields about 50 miles apart and where lights are used to mark the course these are usually about 15 miles apart. For a fully equipped modern airway, complete radio-range beacons, weather broadcast stations and distance-marker beacons are usually required. This type of development has reached a higher stage in the United States than anywhere else in the world. By the end of 1938, the Civil Aeronautics Authority had in operation over 23,723 miles of domestic airways equipped with lights or radio beacons or both and the total of all equipped airways, including non-Federal, reached over 30,000 miles. Even through the depression, American airport and airway construction continued at a rapid pace.

### *The American Airport Boom.*

The Lindbergh publicity of 1927 served its best purpose as a spark to touch off a boom in municipal airport construction that continued until interrupted by the general business crash of 1929. A few years later this work was resumed when airport construction became included as an important part of unemployment-relief plans of the Federal government. Civic authorities were encouraged to improve their existing airports and to create new airports where they were needed. In carrying out these projects the Federal Works Progress Administration

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rendered important financial aid. Because of the large proportion of the cost of airport improvement that is represented by direct employment of labor, this body applied to airports a substantial part of its relief funds; by 1939 it had aided in airport work to the tune of more than \$112,000,000, not including the rather considerable funds raised locally for purchase of property and for other construction. Among the outstanding airport improvements in the United States within this period were those of Chicago, Newark, Cleveland, Washington, D. C., Rhode Island State, New Orleans, and La Guardia Field at North Beach in New York City. Cleveland at present holds the record for size in a public flying field, its total area being about 1,040 acres. At the moment La Guardia Field—named after the Mayor who worked for its creation—and the Washington National Airport are the most highly developed public airports in America. Of La Guardia Field's total cost of about \$40,000,000, the Federal Works Progress Administration supplied about \$15,000,000; the city of New York furnished the balance. The Federal government furnished all the funds for construction of the new Washington Airport. La Guardia Field did not "put Newark out of business," as some had predicted, for the air lines now make both stops in order to provide adequate service to the vast population of the metropolitan area of New York City.

Although improvement was most pronounced in the United States, great improvement in airports

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took place also in other parts of the world in this same period. Among outstanding European projects were the important improvements and extensions made at Tempelhof (Berlin), Le Bourget (Paris), and Croydon (London). Pan American Airways' airports on Midway and Wake Islands also deserve mention because of their unusual location, on formerly deserted islands in mid-ocean. These two airports formed essential links in Pan American's Pacific routes before these were interfered with by war.

### *The Radio-beacon System.*

Airways radio is still a fairly recent development, although radio telephony was used in flying as early as the closing days of the First World War. Originally it was used only for military operations to provide telephonic communications between aircraft in flight and the bases on the ground. When air lines began operating, the need of better landmarks became so obvious that the radio range beacons (mentioned earlier) were developed. These operate by emitting a double signal consisting of a Morse Code *a* (.-) and *n* (-.), one signal being emitted along one side of the airway and the other signal along the opposite side. The signals are so timed as to spacing that they dovetail into each other to provide an even hum in the pilot's earphones when he is directly on his course and is thus receiving both signals with equal intensity. If he departs from this course, the signal on the side to which he has swung

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comes in stronger than on the other, thus informing him that he is off the course as well as indicating the side to which he has drifted. This important contribution to aviation safety has done much to take air-line operation out of the extra-hazardous class and rank it with other means of transportation. How true this statement is can be seen from even the most casual glance at the statistics of "miles-flown-per-accident" since the range-beacon installation became general. This, however, is only one of the jobs assigned to radio in aircraft operation. For the pilot of every transport liner has also a sending and receiving set (commonly known as "two-way" set) by which he maintains communication with the airports along his route and is thus kept informed of weather changes, the proximity of near-by aircraft and any other information that might influence his direction or course of action.

### *The Radio "Fix."*

At the crossing point of every two intersecting radio courses the pilot receives, for a short space of time, the signals of both sets of beacons. This marks a definite point on the course and serves to give him what has become identified in aviation parlance as a "fix," since it fixes his position as at the intersection of the two ranges on his chart. In this way a series of crossing routes serve much as milestones along the airway. The "fixes" are supplemented by a

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series of "marker" radio beacons, spaced short distances apart along the airway; these emit a characteristic signal that has only a short range and thus provides a series of radio distance markers along the route. To avoid confusion and facilitate identification of the various signals, each range-beacon signal is interrupted every 30 seconds by an identification characteristic, thus indicating to the pilot the station from which the signal is coming. Also, if he continues on his course until he actually flies directly over a beacon, he passes through its "cone of silence"—a space in which the signals become inaudible. This serves to give him still another indication of location as well as to warn him that the *a* and *n* signals that he has been receiving will now be reversed. If the *a* was formerly on his right, it will change to his left and vice versa. The United States now has a relatively complete network of airways marked by 234 or more radio-range beacons. In addition to the beacons, every important airport and most of the air-line despatchers have radio telephone equipment for communicating with the pilots coming in, passing through or taking off. Through this means the ground personnel takes complete control of the movement of all transport airplanes in much the same way as a train despatcher controls train movements on railroads. Radio beams are also used to guide the pilot in making a "blind" landing when caught in a fog that obscures the ground.

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### *Airways Operations.*

In the United States, the Airways Operation Division of the Civil Aeronautics Authority controls flights along the airways and directs pilots as to what altitudes they are to use and when they are to approach an airport. As they enter the local zone of an airport, they pass from control of the Airways Traffic Control office to the control tower operator of the airport, who then takes them "in hand" to direct their actual landing. This system prevents the risk of mid-air collisions when visibility is poor and without it the heavy traffic of modern airports and airways could not be handled in safety. It is not at all unusual for a pilot to receive "hold" orders when traffic is heavy and visibility poor. These orders he complies with by circling over a specified control point at the altitude assigned to him and remaining within a limited area until given orders to proceed. This system allows the airways office to clear the airway along his assigned altitude and it gives the airport traffic controller time to clear the airport runway so that he may come in to land. In the section offices of "Airways," as the division is popularly known, a record is maintained of the progress of each airplane moving along the airway routes within its zone. The positions are indicated by movable blocks on a chart showing the routes and as each report is received the blocks are moved to correspond to the reported position. Flight plans

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are worked out for aircraft by giving consideration to their speed, the wind speed and the distance yet to be covered. Thus is determined the order in which they will arrive at their destinations so that the order of landing can be worked out. As he reports, each pilot is informed of his position and is directed as to what altitude he must maintain until given clearance to come down for a landing. The risk of collision in bad weather is eliminated by lateral separation along the airway as well as by assignment of a different altitude to each airplane in the same general zone. The actual radio telephone contact with the pilots is maintained by the air-line despatchers, the airport control towers and the Civil Aeronautics Authority operators; in order to simplify control, the airway traffic-control stations do not communicate directly with pilots. The job of "Airways" is to map out the movements and its orders are, in turn, transmitted by the others.

## Chapter XVIII

# Photography and Other Uses

### *The First Aerial Photographs.*

LIKE most offshoots of other industries, aerial photography began in a very modest way and it seems doubtful if anyone could have originally foreseen the ramifications that were to develop in this field. The first aerial photographs were taken with ordinary cameras, held by a passenger or pilot while he was leaning over the side of an airplane. These beginnings were shortly before the First World War and a considerable amount of photographic reconnaissance was done in the war—which laid the basis for later important commercial and military developments. The first specialized aerial cameras were made toward the end of this war, but even these were makeshifts and it was not until a few years later that the first really practical aerial camera came into existence. This was Sherman Fairchild's first aerial camera and forerunner of the present-day types. In comparison with an ordinary hand camera, the modern aerial surveying camera is a complicated apparatus. Even in its simplest form it has to have a motor for automatically moving the

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film for successive pictures and a device for accurately timing the interval between them. Some mapping cameras have also an arrangement by which the altitude, magnetic direction, level condition, and time of day are recorded automatically on the film as each picture is taken.

### *Making an Aerial Map.*

Aerial surveying is accomplished by taking a series of overlapping pictures with the aid of this automatic camera while the airplane is flying over the route that is to be surveyed. If a wide area, such as an entire city, is to be covered, it is divided into parallel strips and several trips are made until the entire width has been photographed. Most flights of this type are made at altitudes of from 10,000 to 20,000 feet and in taking the photographs a liberal margin of overlap is allowed to provide a means of checking adjacent prints. After the film is developed, individual prints are made, carefully matched, trimmed, fitted together and finally pasted on a heavy backing to form one large "mosaic" photographic map. Known points on the ground are used as "controls" to help in fitting the prints and to check the accuracy of the scale. The altitude that has been recorded on the film is a further aid in this respect. If necessary, the prints are either reduced or enlarged to obtain the correct scale. These individual prints have another incidental but important feature in the

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fact that they can be used to obtain contours of the terrain surveyed. This is possible through the fact that adjacent prints overlap and thus provide two views taken from different angles. Hence when two such prints are viewed through a stereoscope, they appear to the eye as if in relief and this optical illusion of relief can even be exaggerated by adjustment of the amount of overlap. Through this method there is provided a visual key to the changes in altitude of the area photographed and this is used to obtain contour maps. Starting with some point of known altitude, while the prints are viewed through a stereoscope, lines are drawn to indicate equal altitudes and thus a complete contour map is built up. Actually this work is done not with a simple stereoscope but with a machine operating on the same principle. The method provides a high degree of accuracy and makes it possible to obtain surveys at a small fraction of the cost of sending ground crews of surveyors over the area to obtain the same information with rods and transits. Not only is aerial surveying cheaper, almost magically faster and complete to the smallest detail but also it has in its favor the additional advantage of complete secrecy for the operations. This is often a vitally important factor in making preliminary surveys of alternate routes for highways, power lines or railroads, where any "leakage" of advance

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information might cause a serious increase in the cost of acquiring the desired property.

### *The Beginning of Aerial Surveying.*

Sherman M. Fairchild, who has probably done more than any other single individual to make aerial surveying a business, started in this field mainly to provide a market for the mapping cameras that he had developed. Beginning his surveying operations as a side line in 1921, he organized Fairchild Aerial Surveys, Inc., in 1924. This company's first job was a large one—to make an aerial map of Greater New York, covering an area of 620 square miles. The contract served largely to establish aerial surveying as a business, although much educational work remained to be done, for the idea was still a novel one. At first few were willing to believe that a pilot flying over a route at a speed faster than that of an express train could bring back in an hour as much information as a ground crew could obtain in several months. Since that time the method has become generally accepted for civil and military purposes in all countries. Government departments use aerial surveys for crop reporting, flood control and soil conservation. Today no power company or railroad would think of starting work on a new line without first ordering an aerial survey of the alternate routes that might be considered and

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military campaigns depend upon aerial photography for their information on enemy lines.

*"Skywriting."*

Advertising became another civilian activity into which the airplane fitted itself after the war—one of the first and perhaps the most publicized applications being "skywriting." This is an entirely novel kind of advertising—one that has had no precedent and that was highly spectacular when first introduced. Invented by Major Savage, a former British Air Force officer, the method requires an airplane provided with apparatus for injecting oil or other suitable materials into the exhaust pipe leading from the engine so that the airplane leaves a trail of smoke in its wake. In skywriting, the airplane is first climbed to a rather high altitude, usually about 10,000 feet. This is desirable for several reasons. For one thing, the air at that height is relatively free from gusts and the writing thus remains visible longer. For another, the airplane requires considerable space in which to turn; this fixes the size of the letters to some extent and in order to make them conveniently visible a high altitude is desirable. Having attained his operating altitude, the pilot flies a course in the form of letters or words, meantime leaving behind the trail of smoke that thus forms words spelled out against the background of the sky. As each letter is completed, the smoke-making feed is cut off until

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the airplane is flown around to the point from which the next letter is to start. Depending largely upon wind conditions, the letters remain perfectly formed and visible in the sky for several minutes or more. These pilots have become quite proficient in thus writing their messages in the sky and for several years after the war the plan had considerable vogue in advertising various products. It still continues in practical use although no longer attracting such very wide-spread attention as it received at first. Other advertising applications of the airplane have included a variety of schemes such as the carrying of signs (sometimes lighted for use at night), dropping of advertising literature, broadcasting of messages vocally by loud-speaker installations, and the trailing of advertising kites. None of these methods ever had quite the vogue of skywriting when it was at the height of its popularity. In many cases, local action was taken against the plan of dropping leaflets and there has also been objection to the loud-speakers as public nuisances.

### *Insect Extermination.*

Perhaps the most unusual purpose to which the airplane has been applied is in insect extermination. This is quite a story in itself and one of enough interest to warrant repetition. Back in 1921, some very fine lawn trees on a certain Ohio estate were being rapidly denuded of their leaves by swarms

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of caterpillars that descended like a plague on that area. Machine spraying proved to be totally incapable of exterminating the pests yet nothing else offered any more promise. The sprayers were at work one day under the watching eyes of C. R. Neillie, City Entomologist of Cleveland, but the liquid was falling far short of reaching the uppermost branches. Someone jocularly remarked that "Only birds could get the stuff up there." The comment set Neillie thinking of airplanes. It seemed a far-fetched idea and not in the least promising, but nothing else had been effective and it might be worth looking into. With this in mind, he communicated his thoughts to some officers at McCook Field, the Dayton experimental station of the Army Air Service. To his pleasant surprise he found that it sounded promising to them, Lieutenant J. A. MacReady (who later became famous for his high altitude flights) volunteered to cooperate, and the Army gave its approval. A simple device for distributing insecticide was built, installed in an Army airplane and, when appropriate weather came, MacReady flew over from Dayton to begin discharging the powder. Carried by the wind and the powerful blast of the propeller, the insecticide was most effectively distributed. Indeed, the plan worked even better than had been expected—covering the trees thoroughly. A few days were allowed to pass before the experimenters returned to look for results.

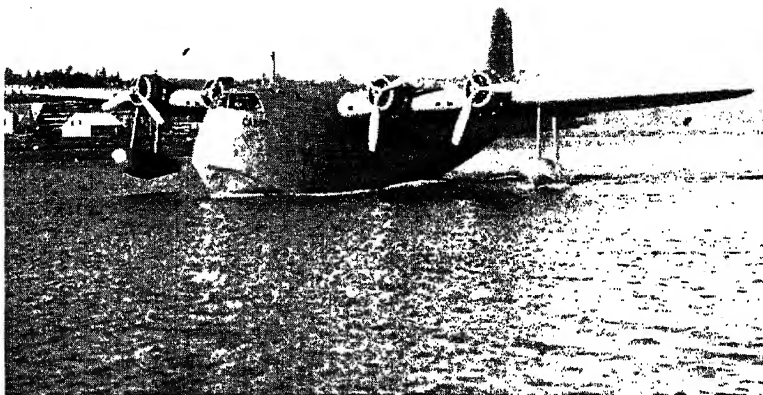


FIG. 51.—The “Cabot” is one of Imperial Airways’ transatlantic type flying boats.  
(Copyright by “Flight.”)

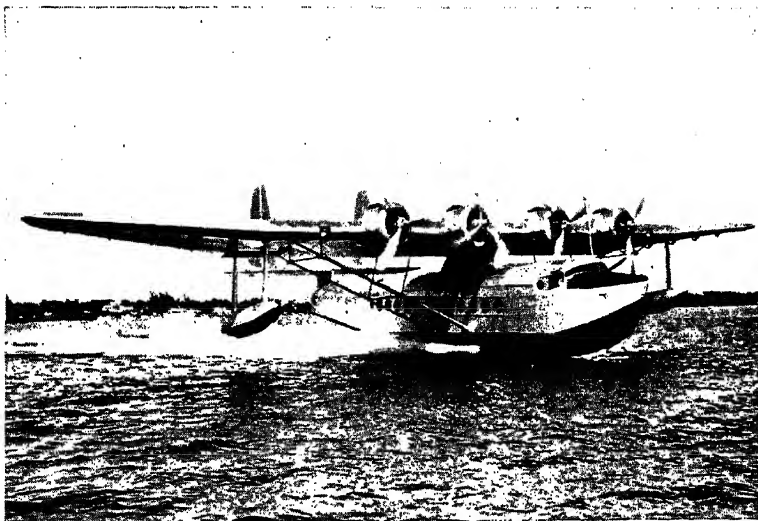


FIG. 52.—Taking off a big Sikorsky flying boat of the Pan American Airways fleet.

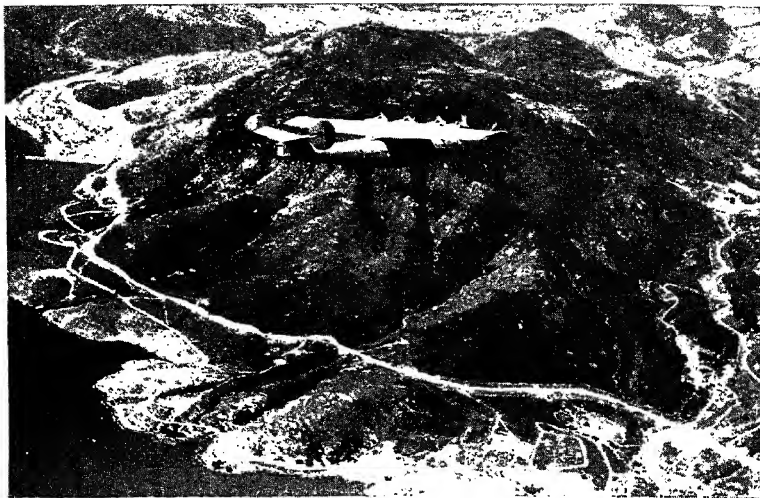


FIG. 53.—One of the big ocean-going flying boats built for the United States Navy by Consolidated Aircraft Corporation. (*Official photograph, United States Navy.*)

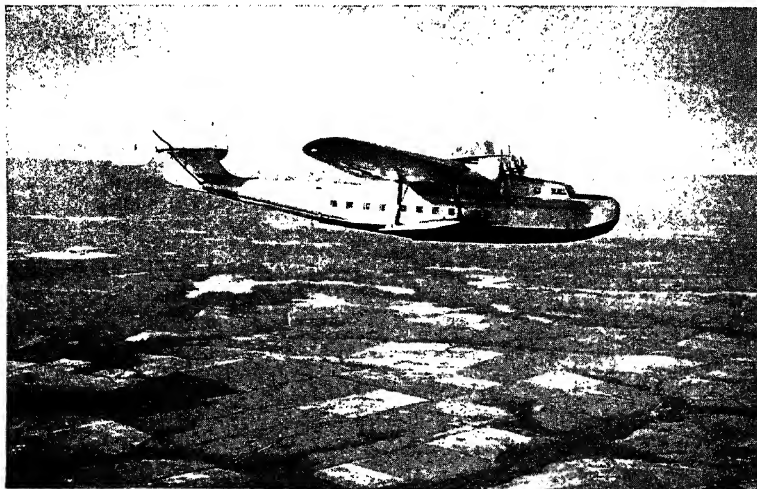


FIG. 54.—The Glenn L. Martin Model 156 ocean transport in flight.

## PHOTOGRAPHY AND OTHER USES

Optimistic as they had been, the efficiency of the scheme passed their wildest expectations; the area was literally strewn with dead caterpillars. One of the observers estimated that at least ninety-nine per cent of the pests must have been killed by this one spraying.

### *Ending the Boll Weevil Menace.*

A report of this experiment reached the ears of Dr. B. R. Coad of the U. S. Department of Agriculture at just about the time that the Federal government seemed to be facing defeat in its war upon the boll weevil, which was then devastating the Southern cotton fields. This, of course, was a totally different problem, but conditions were desperate and the department had reached the stage where it was willing to try anything that offered the faintest hope. Again the Air Service offered its aid and some tests were made. This time the flying was done at a very low altitude—only about 5 to 25 feet above the ground in order to make fullest use of the propeller blast in distributing the powder insecticide. Once more results were beyond expectations; driven by the terrific blast of the propeller, poison dust coated the cotton plants with an efficiency and thoroughness never equaled by other methods. Very quickly some firms began to make a specialty of this work and for a few years “cotton dusting” was quite a lucrative business. Later it

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developed that the inherently seasonal nature of the work precluded it as a specialized business. In more recent years the operators engaged in cotton dusting have been either barnstormers or fixed-base operators who made this only one of their varied activities—substituting passenger seats for dusting devices, or vice versa, to meet the demands of the moment.

## Chapter XIX

# Some Interesting Devices

### *The Automatic Pilot.*

AVIATION has so many interesting accessories that our story must be confined to mention of only a few. The Sperry Gyropilot, for example, invariably excites interest because of its almost uncanny ability to fly an airplane. The present mechanism is a development of the original automatic stabilizer that began in 1909 with the early work of the Sperry Gyroscope Company, whose gyroscopic stabilizer won a prize in France in 1914. Nothing to speak of resulted from this work immediately, mainly because Sperry was much ahead of the times. Indeed, it was not until the advent of large passenger-transport airplanes that there came to be a real need for such a device and when it did come it was for a different purpose—for the relief of pilot fatigue. Sperry had originally conceived of a device to hold the airplane on an even course in the belief that automatic stability was essential to safe flying. It was soon found that airplanes could be built that were sufficiently stable for ordinary use; more than that, they could even be constructed with such complete stability that

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they could not be easily handled. This development eliminated a pressing need for automatic stabilizers for the time being, especially since they meant more weight and weight at that time was a serious mechanical problem. Fortunately, the Sperry Company never accepted this lull in interest as final and the development was continued off and on, as opportunity presented, until it eventually resulted in the present apparatus. In more recent years a new field appeared with the creation of long-distance air routes that required the pilot to fly for a few hours at a time. Here the automatic pilot came into its own when, about 1933, the need arose for some device to relieve pilots from the continued strain of such long flights. Hence it came about that the automatic pilot has been adopted by many of the air lines. The device now in use takes over such complete control of the flying of an airplane that it has been likened to a human brain. The essential feature is a pair of gyroscopes. Each of these revolves at high speed; one has a horizontal axis; the other, a vertical. Since a gyroscope resists any change it follows that a bank, change of incidence, or any other deviation from the set course will result in the airplane's turning in relation to either or both of these small gyros. The instrument thus "senses" very quickly any deviation from the set course and the extreme alertness of the Gyropilot becomes another reason for its use, since such sensitivity makes for smoother

## SOME INTERESTING DEVICES

flying. Having detected a deviation, the gyro (by the change in its relative position) releases a delicate air pressure that, in turn, operates a valve controlling the flow of oil to a cylinder and piston. These, in turn, act as a servomotor to operate the controls, thereby returning the airplane to the normal position. The entire operation is completely automatic, but the device is arranged so that the pilot can easily throw it out of operation as soon as he wishes to resume manual control, such as for landing.

### *Pilotless Airplanes.*

While we are on this subject we must not overlook another interesting if not yet fully perfected application of the automatic pilot. This is the radio-controlled airplane, first experimented with in the United States during the First World War by Lawrence Sperry and his father, Elmer A. Sperry. The end of the war interrupted their work, but it was subsequently taken up by others and interesting results have been obtained here and elsewhere. In many tests airplanes have been flown while completely controlled by radio. By the use of an "automatic pilot" to operate the controls, they have been taken off and flown along a desired course. However, the method has not yet been sufficiently perfected to warrant its use in warfare. If it could be perfected an army could send out a fleet of these pilotless airplanes, loaded with bombs to be dropped upon the

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enemy. They could, at the option of the attackers, be sacrificed by being dived upon their target with their load of bombs or they could be caused to drop the bombs and return to their base for another load. Thus a complete bombing raid would be conducted without risk of the loss of airplane crews. This seemingly ideal scheme runs up against two serious difficulties: First, there is the fact that this apparatus is not yet out of the experimental stage and it is yet too early to promise that it can be made practical. Second, there would still remain the possibility of the enemy's using its own radio to interfere with control of the pilotless bombers, perhaps even causing the bombs to be dumped on the heads of the senders.

### *The Link Trainer.*

With the increased demand for flying instruction, the high cost of actual flight training and the necessity that the pilot be able to fly by the use of instruments when he is caught in fog, every effort is now being made to give as much as possible of this training on the ground. To provide a more economical and, incidentally, more efficient method of training, a device is now being used to instruct in operation of the controls and to drill pilots in instrument flying without their having to leave the hangar or school building. This is the Link trainer, named after its inventor, a device slightly resembling a stubby airplane fuselage. It has the usual pilot's seat and an

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instrument board carrying flying and navigating instruments and controls such as are in general use in airplanes. It also has provision for covering over the normally open cockpit to blind the "pilot" as to what is going on around him; this last feature is used in training for (or checking proficiency in) flying by the use of instruments alone. The trainer sits upon a mount that allows movement in any direction and is so balanced that it has no stability. The "pilot" has to maintain it in normal position by the use of his controls and the device responds to use of these controls in a manner simulating closely that of a real airplane. External control is also provided at a near-by desk at which sits an instructor who can, by use of his controls, tilt the trainer to any angle, just as a gust might tilt an airplane. When it is used for training novices, the instructor throws the trainer out of balance and the budding pilot is required to bring it back by the proper use of his cockpit controls. Although the trainer was originally invented for and has been of immense value in preliminary training of novices prior to actual flying, it has been found useful for other purposes also. Of late, it has been used extensively for "blind" flying training of otherwise experienced pilots. Blind flying means flying by the use of instruments alone and such training is given to prepare a flyer for contingencies when poor visibility makes blind flying necessary. When used

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for blind-flying training, the cockpit is hooded over and the pilot is required to correct the position of the device solely from the readings of his instruments. He can also be trained to locate himself and to follow a set course by use of facsimiles of the usual radio beacon signals; these are transmitted to him through headphones, as in a real airplane. In this way the instruction is given under conditions simulating those of an actual airway flight. The "pilot" starts his "flight" from some specified point and is required to find his location from time to time by means of the simulated radio signals and then to select his flying course accordingly. Meanwhile, the theoretical "flight" is recorded upon a chart by means of a three-wheeled device (called the "crab," because its appearance suggests one) that moves over the chart at a rate corresponding to the theoretical speed of the airplane and takes its direction from the controls in the cockpit of the trainer. The crab leaves its trail on the chart to show the course that actually would have been flown had the man in the cockpit been a pilot on a real flight. The Link trainer is both cheaper and quicker than actual flight training, as well as having the advantage of making it possible to present any desired set of problems to the pilot to work out for himself. It is, of course, a preliminary to actual flight training in instrument flying, which cannot be wholly replaced.

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### *The Earth-inductor Compass.*

The earth-inductor compass is a most ingenious device that had some vogue a decade ago but is not much used today. This compass depends for its indications of direction upon the magnetic field of the earth. It consists essentially of a generator and an indicator, the generator being of a most unusual type through the fact that it has no field poles in the ordinary sense of the world. Instead, the magnetic field of the earth serves this purpose. The indicator is merely a very sensitive galvanometer that indicates the potential being generated and thus gives a measure of the position with respect to the magnetic poles of the earth. This type of compass started out very promisingly, but it failed to come up to the expectations of its makers. It gained sudden prominence and short-lived popularity when it was adopted for the Lindbergh and Byrd transatlantic flights, but its shortcomings became evident and it dropped out of use after a few years. The chief cause for its discard may be credited to the extreme sensitivity of the apparatus to any movement of the airplane and its delay in stabilizing itself at the correct reading after a turn has been completed.

### *Wing De-icing Equipment.*

Operation of transport airplanes on daily schedule, regardless of ordinary weather variations, brought

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into prominence a problem that had already troubled pilots of the U.S. Air Mail Service. This was the formation of ice on leading edges of wings, on control surfaces, in carburetor intakes and on propeller blades. The problem was a really serious one for several reasons. To start with, when ice formed on the leading edge of a wing it quickly altered the aerodynamic characteristics and performance became seriously impaired. Then, ice would often form around the control surfaces in such manner as to cause the mechanism to jam, with resulting loss of control. In addition to all this, the added weight of the ice was in itself a problem because it formed a useless load that had to be carried and in an extreme case might require a forced landing. Many schemes attempted to eliminate the ice problem, first efforts leaning toward the use of some liquid or paste that would prevent ice from sticking to a wing. All these proved to be failures and the first encouragement came when Dr. William C. Geer, a research chemist working in collaboration with Dr. Merit Scott of Cornell University, developed a vulcanized rubber that continually exudes an oil and thus prevents ice from adhering to its surface. With the cooperation of the Daniel Guggenheim Fund for the Promotion of Aeronautics, the B. F. Goodrich Company, National Air Transport and Wesley L. Smith, the present type of de-icer was finally developed in 1930. This consists of a bag,

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made of the ice-repelling rubber, which is fastened along the leading edge of the wings. A small air compressor is used with an automatic control that can be brought into use by the pilot intermittently to inflate and deflate the bag, thus breaking off any ice particles that may have been particularly persistent in adhering to the surface. This combination works so well that it is now standard equipment on most air lines in the United States. Following the success of the wing de-icer, the "slinger ring" was developed for throwing oil on propeller blades to keep ice from sticking to them. Formation of ice in air intake and carburetor passages has also been a cause of some forced landings. This aspect of the ice problem is now met by the use of carburetor and air-intake designs that tend to remove the conditions favoring ice formation in the passages.

### *The Autosyn and Selsyn.*

A fairly recent innovation in aviation (based upon old principles) was made necessary by the multiplicity of the instruments in modern multiengined transports. These had grown into such batteries that in some of the many-engined craft it was becoming difficult if not impossible for the pilot to watch all of them, even when it was possible to find space for them—which also was becoming difficult. To contend with this condition, the Pioneer Instrument Company developed its Autosyn—which was later followed by

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the General Electric Company's Selsyn, a slightly similar instrument. Each is an apparatus by which the indications of any selected instrument or group of instruments can be repeated on the pilot's instrument board at his selection and convenience. The method of operation is simple. The Autosyn makes use of alternating current and the principle of synchronizing one motor armature with another. The measuring element of any instrument, such as an oil-pressure gauge or tachometer, for example, rotates an armature as it moves. Alternating current is supplied to the circuit and the two armatures are so wound and connected that the one on the board follows exactly the movement of the other, which may be, for example, out in an engine nacelle. The Selsyn operates on direct current instead of alternating current but performs a similar function. Here the transmitter consists of an endless resistance winding to which current is applied at two points by movable arms. Three wires, tapping the resistance winding at equidistant points, connect to an armature winding in the indicating device. When current is applied, the armature of the indicating device rotates to a position corresponding to that of the transmitter. Thus, with either type of instrument, we get a reading that is available to the pilot at will. By turning his selector switch, he may take readings of one instrument after the other in rapid succession. A single dial can thereby serve for many and clutter-

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ing up the board with separate instruments for each engine or each purpose is therefore unnecessary. Chief advantages, however, are in elimination of the necessity for bringing pressure lines and tachometer cables into the control compartment and in the ability to make readings available in more than one place—such as in both pilots' and flight engineers' compartments.

### *The Radio Altimeter.*

The year 1938 saw the perfection of a device that had been under development for several years. This is the terrain-clearance indicator developed by Russell C. Newhouse, of the Bell Telephone Laboratories, in collaboration with the staff of United Air Lines. The apparatus is almost uncanny in its operation. It emits a high-frequency radio wave that is reflected back to the airplane by any object that it may strike. The infinitesimal time elapsing between the departure and return of this wave is measured by the apparatus and used to give a direct reading in feet of the distance from the nearest object causing the reflection. As demonstrated in actual practice in the last few months of 1938, the apparatus faithfully registered every change in the terrain below—even to indicating the presence of the George Washington Bridge structure as the airplane passed over it in the flight. One technical observer who was privileged to witness this demonstration expressed his amaze-

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ment by saying that he would not have believed it had he not really seen it with his own eyes. The value of this altimeter becomes incalculable in flying through fog that obliterates all view of the ground below, especially where the hazard of hitting a mountain has to be considered. Recently, during the Second World War, an apparatus embodying similar principles was developed for the purpose of detecting enemy aircraft and was put to effective use in the defense of Britain.

Another interesting development of 1938 was the index-finger radio direction finder. This instrument uses the old principle of a "homing" beacon—the type that broadcasts a signal equally in all directions and depends upon receiving apparatus to identify the direction of reception. The index-finger apparatus eliminates the need of obtaining bearings manually and the pilot needs only to dial the wave length of the station or beacon upon which he wishes to get a bearing. Thereupon the apparatus automatically rotates a loop antenna and the indicating finger on the dial, following this, points directly to the station. It is not even necessary to have radio beacons to use this device, for it can be tuned in on any ordinary broadcasting station if desired. The unique apparatus was the joint work of the Sperry Gyroscope Company and the RCA Manufacturing Company.

## Chapter XX

# Modern Air Transport

### *The Start of Pan American.*

A STORY that reads like a romance of modern business began in 1927 when Captain John K. Montgomery and some associates organized a company under the name of Pan American Airways, with the modest intention of operating an air route across the Caribbean Sea. At about the same time another concern was organized by Juan T. Trippe with the support of a substantial financial group that included W. A. Harriman, W. H. Vanderbilt, Sherman M. Fairchild, John Hay Whitney, William A. Rockefeller, Grover C. Loening and several others. This company took the title of Aviation Corporation of the Americas and began with \$300,000 of initial capital. After surveying the field of operations this group decided to unite with Montgomery's, the combined organization taking Pan American's name. The first operation—on a very modest scale—was a route between Miami and Havana that was started October 28, 1927, and was operated with landplanes very successfully, pending the development of suitable flying

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boats, which were substituted a few years later. From this unpretentious start there was to grow the gigantic and world-wide network of routes that forms the present Pan American System. On the initial route from Miami to Havana only mail was carried until operations were sufficiently established to warrant solicitation of passengers; hence the first passenger traffic was not carried until January 16, 1928. Beginning with this small operation, the company added one route after another until it extended down both coasts of South America, spanned the Pacific to China and Australia and crossed the Atlantic to Europe. Its first move in this expansion was made when it extended its routes across the Caribbean Sea to Central America. Shortly afterward extensions were made down the west coast of South America in partnership with W. R. Grace & Co., operators of the Grace Steamship Line. The growth was amazingly rapid. At the end of 1928 Pan American was operating only 251 miles of route; by 1929 this had increased to 12,000 and by 1930 the New York, Rio and Buenos Aires Air Line had been taken over, giving Pan American a route down the east coast of South America also. In rapid succession still other lines were added and by 1938 the system included routes in Alaska, a substantial part of the China National Aviation Corporation, a transpacific line to China and Australia and a line to Bermuda as a first step towards crossing the Atlantic. In 1939 the Bermuda

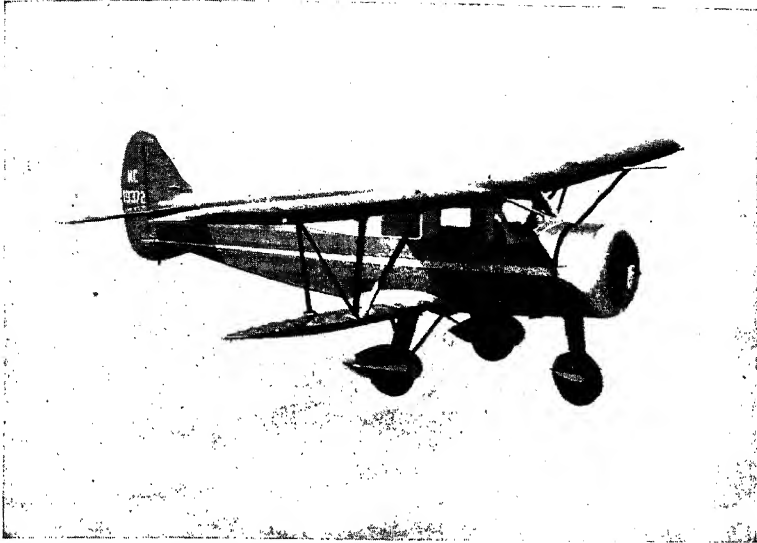


FIG. 55.—One of the Waco airplanes which have been much used by private flyers.

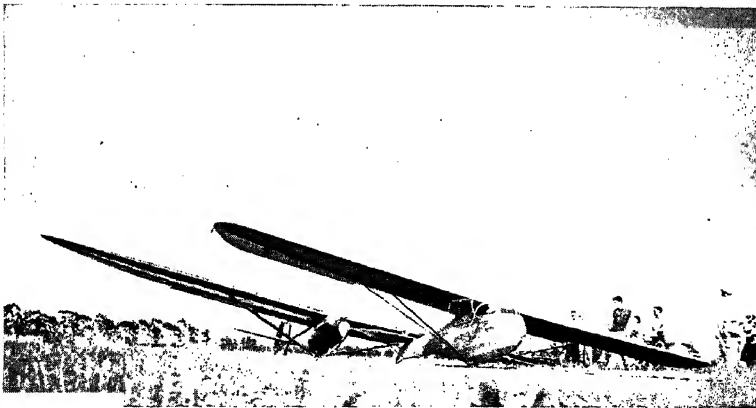


FIG. 56.—Two American gliders or sailplanes—Bowlus's Baby Albatross on the left, and Briegleb BG-1 on the right. (*Courtesy of "Aviation."*)

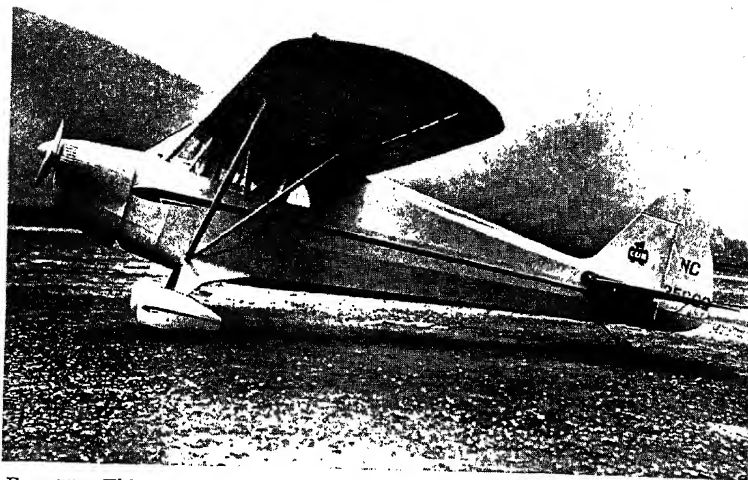


FIG. 57.—This 50-65 horsepower Piper Cub has been one of America's best-selling lightplanes.

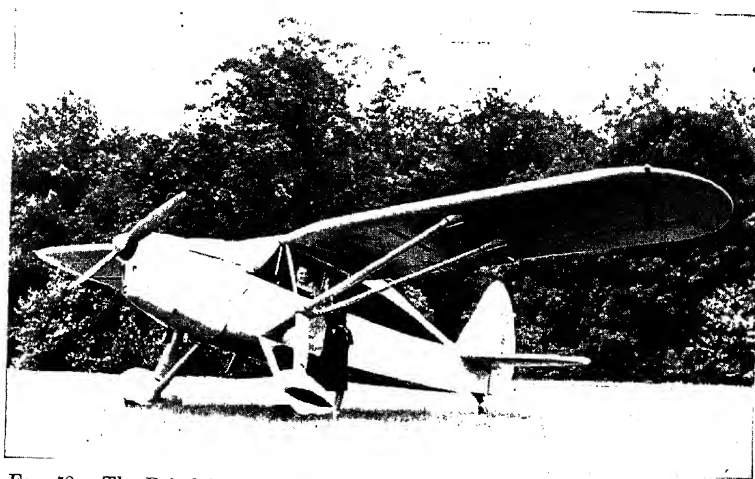


FIG. 58.—The Fairchild 24K, another, but somewhat larger, type that is flown by many private owners.

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route was extended the rest of the way to Europe and the first regular transatlantic service begun. Some further additions have since been made and, by 1942, the system included 98,000 miles of route and was, by a huge margin, the largest in the world. A mental picture of its size may be gained from the fact that by the fall of 1942 Pan American had 22,000 employees and a fleet of 165 large transport airplanes and big flying boats. Credit for the creation of this huge system has been due largely to the genius of Juan T. Trippe, whose foresight and ability to sell his ideas to capitalists and to various governments resulted in the financing and mail contracts that made the expansion possible. War in the Pacific has drastically affected Pan American's civil operations in that region in recent years. On the other hand, in 1941, it was assigned the task of ferrying Army bombers to Africa. Later, this function was militarized under the Air Transport Command.

### *Not without Its Humor.*

Amusing incidents have resulted elsewhere in air-transport pioneering, but Pan American, in its invasion of the Far East, had its full share of these. Before the war, its airport manager in Hongkong sent through to the New York office a requisition for "one 36-inch brunette doll," to be charged to operations expense. This unusual request was promptly challenged by the alert purchasing depart-

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ment and the requisition held up pending some explanation. From this a story ensued. When the first of the "clipper" ships headed across the China Sea from Manila, it had been preceded by the usual arrangements to provide a beaching crew to haul the big boat ashore. As the captain taxied toward a mooring buoy in the muddy river off Kai Tak Airport, he was dismayed to see a bulky woman in native dress coming out to meet him instead of the expected mechanic in Pan American overalls. Before the surprised crew had time to recover fully from its shock at the sight of this "experienced mooring officer," the woman was deftly hitching handling lines to the big clipper and calling orders in Chinese to fifteen coolies who were wading out to catch the lines and haul the ship ashore. "Sampan Annie" she became then and there; and she subsequently took charge of many moorings for Pan American. On this occasion, however, when the clipper was due to leave, Sampan Annie failed to appear on time and arrived just as the coolies, in charge of her husband, had succeeded in getting the clipper hopelessly stuck halfway down the ramp. Scattering them with one reverberating bellow of her powerful voice, Annie stooped under the bow and worked the craft free by heaving with her broad shoulders. It was some weeks later before the airport manager learned that her lateness that morning had been due to her giving birth to a baby girl just before the clipper was due

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to leave! This lengthy explanation forthcoming, the doll requisition was approved and the story, passing on its rounds of the office, landed in the publicity department—where it was eagerly pounced upon and made good use of!

### *Lufthansa.*

Before the Second World War, Pan American's closest rival in size was the Deutsche Lufthansa, a consolidation of two earlier German companies. The first air-transport company in Germany was the Deutsche Luftreederei, founded in 1917 by the Deutschebank and Allgemeine Elektrizitäts Gesellschaft—the German General Electric Company, or A.E.G., as it is often referred to in English. Delayed by the war, the new company did not open its first route, between Berlin and Weimar, until February 5, 1919. On this line it used converted military airplanes at first, but a few months later specially built Junkers commercial types were put into service. Restricted from military activities by terms of the peace treaties, Germany centered her attention upon commercial aviation and this company began to increase its mileage and number of routes. By 1926 it was operating 3,732,000 airplane miles a year in Europe alone, linking most of the important German cities as well as extending beyond its borders into adjacent countries. Before operations became affected by the war in 1939,

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this figure was about doubled. The present Deutsche Lufthansa Aktiengesellschaft is the result of a consolidation, effected in January, 1926, of the two formerly competing German air-transport firms of Junkers Luftverkehr and Deutscher Aerolloyd. The present company now forms a monopoly of air transport within Germany and, since 1938, also within the territory that was formerly Austria. Presumably it also has been given a monopoly in most of the occupied countries. Although rated as a private enterprise, it has the whole-hearted support of the German government, which also has a substantial financial interest in the company. Lufthansa's first night route was operated between Berlin and Koenigsberg, beginning on May 1, 1926. The shorter distances in Europe (as compared with the United States) making the need of night routes less pressing, no European country has developed night operations to the same extent as America. Germany, the leader in night flying in Europe, had only 3,050 miles of night routes in 1938 as compared with 33,239 miles here at about the same date. Germany, later, took up blind-landing systems very seriously and in 1938 Lufthansa had equipped sixteen airports with the Lorenz short-wave-radio landing-direction system.

### *Diesels and Catapults.*

Always quick to pioneer, in 1931 Lufthansa decided to embark upon the use of Diesel-type

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engines upon a substantial scale, extensive test flying having seemed to warrant this policy. A number of airplanes used on regular routes were operated with Junkers Diesels and craft thus equipped were used in many of its regular flights in the South Atlantic service and in demonstration crossings of the North Atlantic in 1936, 1937 and 1938. Subsequently, however, many of the Diesel-engine installations were replaced by direct-injection gasoline engines on the domestic services in Germany. Lufthansa was also the first to make use of the catapult for launching of modern mailplanes. Before improvement in flying range made it practicable to cross the South Atlantic in one hop, this company used two catapult-equipped mother ships in mid-ocean to permit refuelling on the way across. Its regular service on this crossing was begun on February 3, 1934, after a number of preliminary investigation flights in the preceding years. Later, the increase in flying range made it practicable to dispense with the mid-ocean stop and the flight was made in a single hop. Only mail has been carried on this route, but passengers were to have been carried, beginning in 1940, had these plans not been interrupted by war. Beginning in 1929, this company also made use of a catapult to dispatch airplanes from German liners as they approached the American and German coasts, thus advancing the speed of mail delivery. The first such flight was made from the *Bremen* on its maiden

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trip to New York, a small Heinkel seaplane leaving the liner on July 22, 1929, while she was still 250 miles off the coast. The little seaplane landed safely in New York Bay some 2½ hours later. This experiment was so successful that Lufthansa next tried, in August, 1929, the plan of sending the seaplane with mail out to catch the liner after it had left port, thereby saving still further time in transmission. The growth of world air transport before the Second World War was rather vividly illustrated by the unique "Reichsluftkursbuch" (German Air-line Guide) compiled by Lufthansa with the support of the German Air Ministry. This publication undertook the ambitious job of including within the covers of a single volume the time tables of nearly every air line in the world, an accomplishment that necessitated almost 500 pages of closely printed small type.

### *Each Nation Fostering Air Transport.*

Until interrupted by the war, nearly every important nation of the world had its air-transport system, some confined to internal services and others extending their routes to foreign countries. In general, most of these systems followed somewhat the patterns set by Lufthansa, combining all operations under one company, which usually became a quasi-government activity. Holland's international system, which was one of the oldest and which extended to colonies in the Far East and included routes in the West

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Indies, was operated by Koninklyke Luchtvaart Maatschappij—in the interests of simplicity, better known in the United States by its initials, K.L.M., or its English translation of Royal Dutch Air Lines. France's great foreign air-transport organization was Air France, which represented another consolidation of earlier companies. The beginning of this system grew from a proposal made by the Compagnie Générale d'Entreprises Aéronautiques on September 7, 1918, for the operation of a line between France and Morocco, French West Africa, and South America. In December, 1918, this firm began flying operations between France and Barcelona, initiating a service that later expanded to form the French route to South America. The initial South Atlantic crossing by this route was made on March 1, 1928, when regular mail service was established between Dakar (Africa) and Natal (South America). Another air line that figured in the early history of postwar transport development was the German-sponsored Sociedad Colombo-Alemana de Transportes Aereos—so much better known by its initials SCADTA that few people remember its real name. Starting its operations along the Magdalena River in 1921, this firm earned the very notable distinction of closing its first year of operations with a profit. This unusual achievement was due mainly to the careful choice of its field of operations; for the Magdalena River is a notoriously temperamental medium of transport in

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the dry season, although it has to serve as the main artery in Colombia's entire system of transportation. Before SCADTA had been long in operation, its passengers found occasions during the dry season when a trip that they made in 10 minutes would have taken 9 days by steamer! In 1929 control of SCADTA passed into the hands of Pan American Airways; a recent Colombian law required all air lines to be nationalized; hence SCADTA has since become Aerovias Nacionales de Colombia. This company, usually referred to as AVIANCA, is controlled by the government of Colombia, but Pan American retains an interest.

Another company operating in several of the Central American countries is the Transportes Aéreos Centro-Americanos, which also is known by its initials as TACA. This began as an independent company that started with small capital and built up a substantial business in carrying just plain everyday freight to relatively inaccessible places in these countries. The "butter-and-egg run," it was called by one writer in telling the story of the company's growth from a shoestring operation to a first-class enterprise through depression years in which most of the better established industries were suffering heavy losses.

### *The Empire Air Mail Scheme.*

The start of a most ambitious air-mail plan began in March, 1924, when Imperial Airways was organized

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as the "chosen instrument" of the British government for the purpose of developing British international air lines upon an economic basis. Daily service between London and Paris, the first operation of the new company, began in April of the same year. This was followed by services to Cologne, Basle, and Zürich a few months later. Extensions to the colonies were undertaken step by step during the several years following and plans for the Empire Air Mail Scheme, were announced in December, 1934, to become effective in 1937. This plan contemplated linking the entire empire by air-mail services upon which "as a matter of principle" all letter mails to and from the United Kingdom were, so far as practicable, to be carried by air without extra charge. Since then Imperial has grown into a system that connects nearly the entire empire and that, by 1939, was operating a total of about 30,000 miles of air routes. The first step in this plan went into operation with the beginning of service between Great Britain and South Africa in June, 1937. Service between England, India and Malaya began in February, 1938; service to Australia followed later in the same year. Service to Canada, via Newfoundland or the United States, according to the season and weather, was to be operated, starting with the summer of 1939. However, the plan of carrying air mail without surcharge was modified in 1939 when war broke out and operating plans for the Atlantic service were also changed. As a

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component part of the British Empire Air Mail Scheme, a new transcontinental route was created across Canada, under the name of Trans-Canada Air Lines. This was created by act of the Canadian Parliament in April, 1937, and is being operated as a government activity. Starting from scratch, the entire \$5,000,000 trans-Canada system was constructed, equipped with the very last word in facilities, and put into operation from Montreal to Vancouver by 1939.

### *Air-rail Transport.*

As we have observed, the several years immediately following the passage of the Kelly Air Mail Bill became a period of intense activity in the creation of new air routes in the United States. During this stage some of the biggest railroads began to show an interest and by 1928 the Pennsylvania Railroad, in collaboration with aviation executives and bankers, had organized Transcontinental Air Transport, Inc. This firm was created for the specific purpose of operating the air-transport unit of a transcontinental service for carriage of passengers in conjunction with railroads. Under the operating arrangement, passengers would use the Pennsylvania lines for an overnight journey from the East Coast to Columbus, Ohio, where they would board airplanes and fly by day to Clovis, New Mexico. Here, they would board trains of the Santa Fé Railroad to complete their

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trip. After very elaborate preparation and some special airport construction, TAT announced that it would start to carry mail on Sunday July 7, 1929, offering at the same time a 48-hour passenger service between the two coasts. Not to be outdone by its rival, the New York Central Railroad did some fast work in effecting an arrangement with the already-operating Universal Aviation Corporation and Western Air Express. As a result, almost coincidental with the TAT announcement and practically without advance notice, the New York Central-Universal Aviation-Western Air Express combination began operation of a competing coast-to-coast air-rail service before TAT actually started running. They even went further and announced a new schedule that cut 2 and 3 hours from the Pennsylvania TAT schedule on the very day the latter went into operation! Such was the rate at which developments were taking place in air transport in the United States around 1929.

### *The Period of Consolidations.*

After the initial rush to start new air lines in the United States, there followed a very logical period of consolidation, an inevitability sooner or later, since air transport is essentially a long-distance operation. At the same time, this consolidation was not confined to the job of putting short routes together—for many of the components in some

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consolidations were already operating over substantial distances, one extending more than halfway across the continent. The original TAT was combined with Western Air Express and some Eastern lines to provide a through route from coast to coast, resulting in the present Transcontinental & Western Air system, which is usually advertised as TWA and now has 4,679 miles of routes. This is now one of the three great transcontinental systems, the second being United Air Lines, which began with the Boeing Air Transport operation of the original air-mail route between Chicago and the coast. Later the service was extended to New York and it now totals 5,467 miles of routes. The third and now largest system is American Airlines, which came into existence originally through the merger of several companies that had been acquired by the Aviation Corporation as a holding company in various aviation enterprises. "American," as it is popularly called, now operates 6,769 miles of routes exclusive of its foreign extensions. This company, incidentally, was the first in the world to put real sleeper airplanes into regular service, when it began operation of its Douglas sleepers in 1936. Eastern Air Transport, last in our listing but normally second in route mileage of the "big four" systems of the United States, operates a network of 4,663 miles in the Eastern and Southern sections of the country. The origin of this system goes back to the creation of Pitcairn Aviation, Inc.,

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which started flying mail in May, 1928. A few years later the Pitcairn company changed hands and in 1930 it became Eastern Air Transport. Extension of routes followed that gave the present company a system that now links the entire Eastern seaboard south of New York, extending also over the Southeast and connecting with Pan American at Miami and Brownsville. These four systems have become the largest in the United States although there are several other lesser but still important systems and many short routes as well. Practically all the systems have had to curtail their services because of war conditions, and most of the larger systems normally operate a substantially greater number of route miles. The wave of consolidation was accompanied and followed by rapid improvement in service. Passenger flying time from coast to coast, which began with 48 hours by TAT in 1929, had dropped to 36 hours by October, 1930. By November, 1932, it was down to less than 25 hours; by April, 1935, the same route was being flown in just inside of 15 hours and still further reduction is planned! Owing to war conditions, the schedule has been temporarily increased since then.

### *The New England Hurricane of 1938.*

In the life of every industry, as in the life of every man, there comes a time when opportunity knocks on the door. Toward the end of September, 1938,

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the U.S. Weather Bureau posted warnings that a hurricane had changed its course, missing Florida, where it had been expected, and that it was now heading northward just off the Atlantic Coast. On September 21 it struck. Sweeping across the eastern end of Long Island with terrific violence, it left a trail of wrecked homes in its wake. Northward it continued over the shores of Connecticut, Rhode Island and parts of Massachusetts before its energy became dissipated. Striking in that erratic fashion so characteristic of a hurricane, it left some sections untouched and others completely devastated. Highways were blocked by debris, sections were washed out and bridges destroyed; trains were derailed, tracks undermined or removed and one train even collided with a large boat that the storm had deposited squarely across the tracks. The New Haven Railroad, which had come to pride itself upon the excellent record of its New York-Boston line, found its tracks cut in several places by washouts, lost bridges, derailments and wreckage strewn by the storm. For two entire days all road, rail and sea communication between these two great cities was completely severed. It was several days more before communication could be resumed on anything even approaching normal basis. In the meantime, the need of transportation became even more urgent than ever. Finding other means at a standstill, many who had never flown before suddenly remembered that American Airlines had swung back into service almost

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on the tail of the storm. The first rush of reservations descended upon its New York office with the irresistible force of an avalanche. The regular daily schedule of ten round trips of its twenty-one-passenger airplanes became fully booked almost immediately and a waiting list started that grew with every incoming telephone message. The regular force worked overtime and emergency help was hurriedly called in. More airplanes were put on until every available craft in the area had been pressed into service. Still the phones rang; still the passenger reservations piled up.

### *Fifty Trips a Day!*

Equipment was rushed east from Detroit and Chicago, only to be fully booked before it could be put into service. Airplanes from St. Louis, Dallas and as far west as Los Angeles were rushed across the continent to answer the emergency. Trips were added to the run until it was operating with the frequency of a streetcar service. Daily runs skyrocketed from ten to twenty, then to thirty and forty. By this time American had crowded on the route every airplane that could be spared from a nationwide system. Still it found itself unable to cope with the tremendous task of providing the sole means of transportation between two great cities. In the face of such unprecedented traffic, other lines were called upon for help. All responded nobly, showing a marvelous spirit of cooperation in this, the

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greatest traffic emergency that air transportation had ever been called upon to face. Eastern Air Transport loaned some of its airplanes; United Air Lines sent others and TWA supplied more, all manned by regular and thoroughly experienced crews. Before the waiting list of reservations was finally brought under control, American had assembled on the 201-mile route a total of twenty-four big air liners, was making up to *fifty-seven trips daily* with well-loaded twenty-one-passenger airplanes and was carrying a total of more than 1,000 passengers a day, about three ordinary trainloads of persons! In the 8-day period that followed this hurricane, the line carried over 8,000 passengers and more than a third of a million pounds of mail. It was a volume of traffic entirely without precedent anywhere or at any time in the previous history of air transport—a volume that made the traffic of entire systems of foreign air lines look insignificant. The great German Lufthansa, with a network that covered most of central Europe, averaged only 760 passengers a day for its entire European system in 1937. And it speaks volumes for the safety of air lines that, even with the pressure of maintaining fifty-seven trips daily, American completed this posthurricane rush without the slightest mechanical or weather trouble.

### *Transatlantic Air-mail Services.*

Air-mail services have been in operation across the South Atlantic for several years, both French

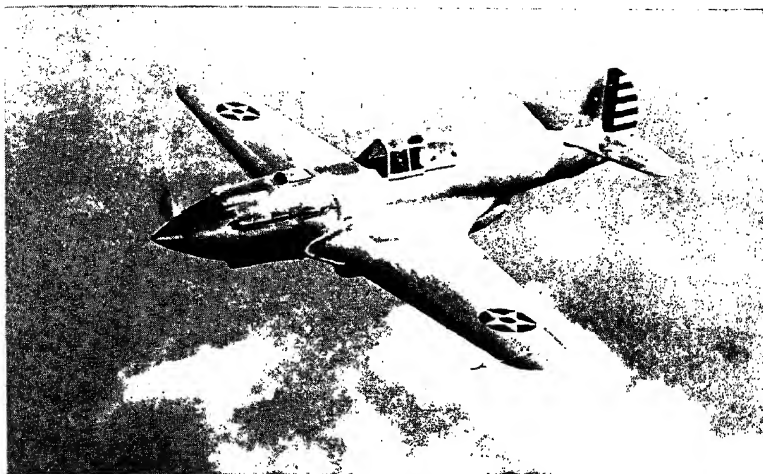


FIG. 59.—This Allison-engined Curtiss-Wright P-40 pursuit—developed for the United States Army—is a successor to the earlier and Wright-engined type that created a sensation in the hands of French pilots during the opening days of the Second World War in 1939.

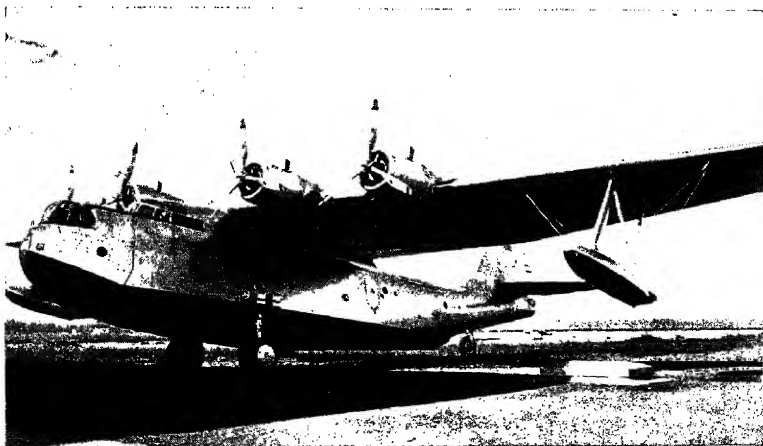


FIG. 60.—“Flying Dreadnaught” built by Sikorsky for the United States Navy.  
(Courtesy of United Aircraft Corporation.)

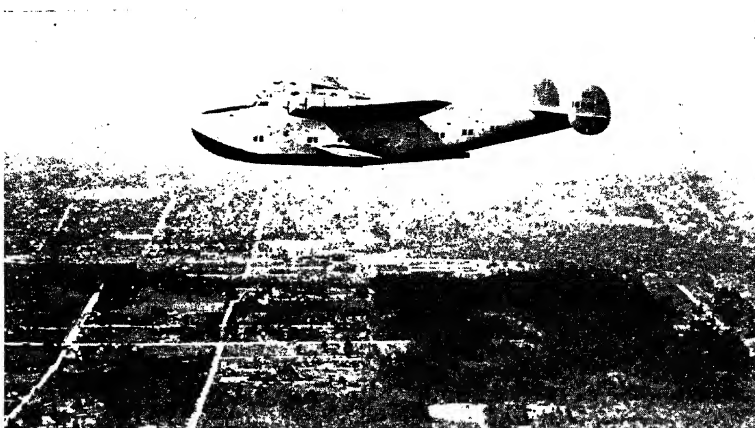


FIG. 61.—This huge Boeing 314 carries seventy-four passengers and weighs 88,000 pounds when fully loaded; it was first built for use on Pan American's ocean services.

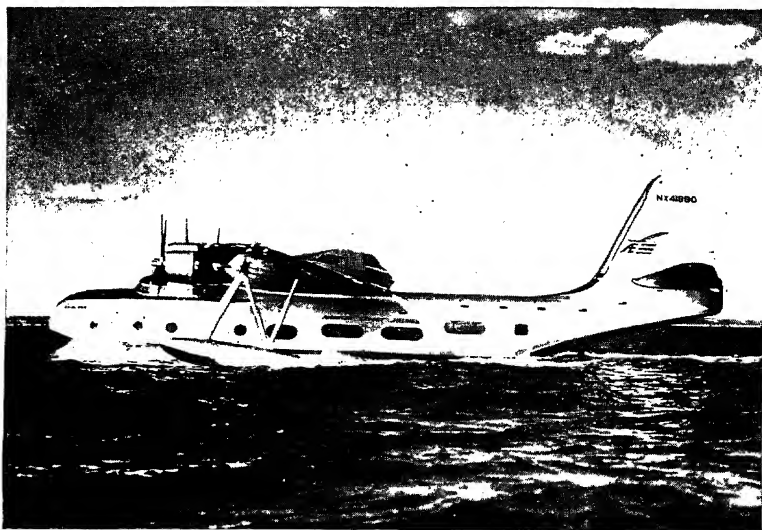


FIG. 62.—Vought-Sikorsky transport flying boat operated by American Export Airlines in its transatlantic service.

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and German companies making their first jump over the ocean between Africa and Brazil some few years before the war. Because of their remoteness from this country rather than from any other cause, these services were not given the attention that they have deserved in the United States. The same thing, however, cannot be said of the well-publicized service started in 1939 by Pan American Airways over the very much greater distance across the North Atlantic between the United States and Europe via the Azores. Ranking as one of the most outstanding developments in air transportation of recent years, this service was inaugurated early in May, 1939, when the first of the big Boeing-built clippers rose from Port Washington, New York, and headed for Europe with seventeen passengers and 1,603 pounds of mail. British, French and German plans for North Atlantic services having been interrupted by the war, Pan American for a time operated this service alone. However, this company did not long retain a monopoly of North Atlantic air mail, for another American firm, American Export Airlines, later began a rival service to Europe. Its projected terminus originally was to be at Rome, with a stop at Lisbon, but the war necessitated some departure from the original plan. In February of 1942 a certificate was obtained for the operation of service between New York and Foynes, Ireland. Proving flights were made in May and June, and regular service was inaugurated in July, 1942.

## Chapter XXI

### Some Recent Events

#### *A Few of the Records.*

AIRPLANE altitude records were pushed upward in 1938 when Lieutenant Colonel Mario Pettzi climbed a Caproni with a Piaggio engine from the Guidonia Airport near Rome to a height of 56,046 feet. Still higher is the balloon record, made in 1935 when Captains Orvil Anderson and Albert Stevens of the U.S. Army ascended to a height of 72,395 feet (nearly 14 miles) in a special stratosphere balloon. From the viewpoint of speed, the greatest attained in level flight was 469.2 miles an hour, a record made by Fritz Wendel of Germany in April, 1939. This record was made in a Messerschmidt BF 109R with a 1,000-horsepower engine. A flight that became one of the most outstanding in the entire history of aviation was made by three British Vickers Wellesley bombers in 1938. These were standard single-engined monoplanes, as used by the British air forces, except for the large tanks with which they were specially equipped for this flight. Leaving the Royal Air Force flying field at Ismailia, Egypt, on November

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5, the three airplanes took off on their epochal flight. By November 8, all three had landed safely at Port Darwin, Australia, 7,162 miles away. Two of the craft had made this distance in a nonstop flight; the third ran low on fuel and made a brief stop at Koepang, 6,600 miles from the start, before continuing on to the destination. Thus all three exceeded a nonstop record of 6,306 miles made by Russians in the previous year.

The Howard Hughes flight around the world marked up another new record in 1938—this one for speed in circumnavigating the globe. Leaving New York on Sunday, July 17, at 7:20 P.M., Hughes and his crew flew to Paris, Moscow, Omsk, Yakutsk, Fairbanks, Minneapolis and back to New York, landing on the return in the afternoon of Thursday, the twenty-first, having completed their trip in the elapsed time of 91 hours, 8 minutes, 10 seconds. This flight was marked by the most thorough preparations of any flight of its kind in recent years. Original plans were started 3 years previous to the flight and everything prearranged with the utmost regard for detail.

*“East Is West.”*

As if to furnish a “comic supplement” in its contrast, Hughes’s start was followed by a hop across the Atlantic from New York to Ireland by Douglas Corrigan, a young and hitherto unknown

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Irish-American pilot. Corrigan's flight was as notable for the apparent skimpiness of the preparations for it as were Hughes's plans for their thoroughness. With no financial backing, Corrigan purchased a secondhand Curtiss Robin, with an engine that also had seen considerable service. Having equipped this airplane with extra gasoline tanks, he landed at New York, at the end of an unannounced hop from California. Saying as little as possible about his plans, he gave the impression that he intended to fly back to California shortly and, about the middle of July, he actually made some inquiries regarding the weather for such a trip. Shortly thereafter he took off. However, instead of heading westward, he flew straight out to sea and was next heard of when he landed in Ireland, where he naïvely asked, "Is this California?" The daring flight bore such a remarkable resemblance to that of Lindbergh as to suggest that the similarity was not entirely accidental. To start with, Corrigan's Robin had lines and equipment closely resembling Lindbergh's Ryan, although Lindbergh's craft was brand new. Then, as Lindbergh had, Corrigan flew unannounced from California through to New York. His youth and the fact that he flew alone carried the Lindbergh comparison still further. Serving as an anticlimax to the Hughes flight, news of Corrigan's adventure dampened only slightly the public enthusiasm for the youth, who returned to the United States to be welcomed as a

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hero—and to explain to the Civil Aeronautics Authority how he came to make the flight without obtaining official clearance papers. Corrigan insisted and still insists that he thought all the time that he was flying to California!

### *Some More Recent Records.*

Glider experimenters continued to push their records to new highs until these had reached almost unbelievable figures in the years just preceding the Second World War. The maximum distance record for a glider is now 465 miles and was attained by O. Klepikova, a woman, in Russia in 1939; Erwin Ziller, a German, reached an altitude of more than 22,000 feet in 1938. The latter and apparently impossible feat resulted from the pilot's utilization of the air currents resulting from long upward slopes. Duration records have been moved up similarly, a nonstop glide of 50 hours and 26 minutes having been made in Germany in 1938 by August Bodecker and Karl H. Zander, who used a two-seat glider and alternated at the controls. Most of these and the records mentioned earlier are official, the figures having been supplied by the National Aeronautic Association—the organization serving in the United States as official custodian of international air records. Whether or not the figures have since been exceeded will not be known until censorship is lifted. Another startling—but not yet official—airplane

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record for duration in flight was attained near Long Beach, California, in October, 1939, when Wes Carroll and Clyde Schlieper landed after having circled in the air for 726 hours. This record exceeded by more than 3 days the previous 653-hour world record for airplane duration. During the flight, it has been estimated, the pair flew about 55,500 miles, this distance serving as a remarkable testimonial to the reliability of modern aircraft engines; it is very doubtful if the motive-power plant of any other type of conveyance could have attained such mileage without interruption. Carroll and Schlieper picked up their fuel supply in 5-gallon cans by flying low over a fast speedboat moving on the water in the same direction.

### *Assisted Take-off.*

One of the serious problems encountered in regular flying over long ocean routes is that of being able to take off safely with sufficient fuel to complete the trip without displacing too large a proportion of the pay load for the sake of carrying this fuel. Since a margin of power is required for a safe take-off with landplanes and since this margin becomes even greater with flying boats, the problem boils down to one of getting the craft into the air. Once it has attained some moderate altitude, it is able to continue its flight with considerably less power. As a result, several methods have been used for assisting

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a heavily loaded aircraft to take off and, in one case, to attain some altitude. The catapult, of course, was the earliest method and, as already mentioned, it is still used for special purposes. Perhaps the most original scheme yet tried for assisting take-off is the Mayo "composite" system, in which one flying boat is used to lift another in taking off. Mayo's plan has been used by Imperial Airways, starting in 1938 with a trip from England to the United States. The scheme makes use of a large flying boat, upon the upper wing of which is coupled a smaller seaplane. The seaplane is so heavily loaded with mail and fuel that it would be impossible, or at least impracticable, to take off without aid. The lower and larger flying boat is less heavily loaded in order that it can do most of the lifting while it is taking off and while the two are climbing to operating altitude. Once this height has been attained, the coupling device is released, whereupon the upper and smaller craft continues on its way and the lower one returns to its base. To facilitate the operation of uncoupling, pilots of the two craft are provided with a telephone connection.

### *Some Airship Construction.*

Despite the tendency to concentrate mainly upon airplanes, with somewhat less attention being given also to rotating-wing craft, the airship and balloon were not entirely overlooked in the years preceding

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the start of the Second World War. In 1938 the Zeppelin Company completed its LZ-130 for passenger transportation on a transatlantic route. It had been planned to use helium to avoid a possible repetition of the frightful disaster that occurred in May, 1937, when the "Hindenburg" caught fire and was destroyed with heavy loss of life when landing at Lakehurst. However, the United States government refused to release a supply of this gas. Since this country has at present a world monopoly of the supply of helium, the refusal forced suspension of the transatlantic service and the LZ-130, inflated with hydrogen, has been used only for experimental flying in Germany. By a strange coincidence, this period of low ebb in airship construction saw the completion of the world's largest nonrigid airship when the Goodyear Company delivered the K-2 to the U.S. Navy in December, 1938. This airship was 246 feet long and 404,000 cubic feet in capacity. At about this time kite balloons also figured in the news, in connection with British plans for the defense of London against possible air raids. One feature of these plans (put into effect in 1939) is a net of wires that is held in the air high above the city by the use of kite balloons. To avoid becoming entangled in these wires, enemy bomber airplanes would be forced to operate at such extreme height that their accuracy would be impaired. Also, since their operating altitude would be limited to a smaller range, they would be much more likely

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to fall a prey to the defending airplanes. The plan had a tryout during the raids on London in the Second World War. No analysis of its efficacy has yet been made public, but the indications point to its having been of some use.

### *The Crisis of September, 1938.*

The historic "Munich peace" of September, 1938, made aviation history, also. For some three years Germany had been assiduously and quietly preparing for aerial warfare upon an unprecedented scale. These preparations apparently culminated during the middle of 1938 when she made demands for annexation of certain areas in Czechoslovakia. This situation threatened to involve most of Europe, since France was an ally of Czechoslovakia and Great Britain was, in turn, an ally of France. Italy was supporting Germany, and Russia was considered a probable ally of the democracies. Adolf Hitler made every show of being ready to back his demands with force; whereupon the democratic nations suddenly awoke to a fearful realization of the extent of his aerial preparations. Mobilization plans were rushed by all sides, and European cities came to a startling realization of their helplessness against aerial bombing. Trenches were hastily dug in public parks, pitifully inadequate bomb shelters were constructed and for 2 weeks the world teetered upon the brink of a war incredibly more terrible than even

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the wholesale ghastliness of 1914–1918. It is difficult to find words truly descriptive of the conditions that followed public realization of the gravity of the crisis.

“For three days the world looked straight into the mouth of Hell,” wrote Paul Johnston, describing the terrifying situation in *Aviation*. And Walter Lippmann of the New York Herald Tribune Syndicate said: “For the first time in the history of warfare the civil population felt itself to be in greater danger than the soldiers at the front; for the first time in the history of modern diplomacy the political leaders felt that they themselves might in a week or so be blown to bits.” Hitler’s show of force called the turn—virtually every demand being conceded. Thus in its first great showdown aerial warfare, by its mere threat, won a bloodless victory for Germany. Subsequent events, however, proved this to be only a temporary advantage. As early as April of 1940 its transient nature had inspired T. P. Wright to comment, “Hitler missed his chance at Munich. Then he had two-and-a half times as many airplanes as the Allies. The tide is now turning. . . .”

## Chapter XXII

# The Second World War

### *A New War Begins.*

A SEQUEL to the "Munich peace" came in the summer of 1939 as the result of new demands made by Hitler—this time affecting parts of Poland. He had evidently counted upon similar tactics to produce another Munich peace, but was greatly misinformed as to the temper of those with whom he was dealing; by this time Britain and France had reached the end of their compromise policy. Hence the invasion of Poland was quickly followed by a declaration of war upon Germany by France and Britain. Before Poland's allies could render substantial aid, mechanized divisions of the Germany army, with the support of a powerful air force, had overrun the country, Russia coming in to participate in its division after the Polish Army had been defeated. Aerial bombing of large Polish cities figured largely in the news and Warsaw was subjected to frightful bombardment, at first from the air and then also by artillery as the Germans drew closer. With perhaps the sole omission of gas bombs, the worst predictions of aerial warfare

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were realized in this attack upon Warsaw. Yet, despite its losses, the city held out until after the rest of the country had been overrun by the enemy. At first Hitler's threat of aerial attacks upon British cities was not carried out. His air fleet limited its initial operations against the British to some reconnaissance flights and to attacks upon warships and merchant vessels; these first moves attained indifferent success, where any.

In these earlier operations the British made similar and extensive flights over Germany, presumably for reconnaissance purposes. Advantage was taken of the occasion to drop millions of propaganda pamphlets in the hope that they might accomplish more than bombs. The surprising success of these raids over German territory, raids which extended as far inland as Berlin and which were not followed by equally successful Nazi raids over France and Britain, led some to question the strength or efficacy of the much-publicized German Air Force. It became obvious that this force was being held in leash for some reason. Later events suggest that Hitler had then hoped to make terms with Britain without resorting to military action. If so, he was certainly disillusioned.

### *Another War Boom in Aviation.*

The start of this war in Europe inspired considerable military aircraft construction in the United

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States and gave added interest to the civilian-training plans of the Civil Aeronautics Authority. Combined, these factors had, by the end of 1940, produced a sizable boom in American aviation. A very comprehensive program was put into effect that provided for training new flyers in cooperation with existing flying schools and colleges. Flight training was greatly reduced in cost to the student by the combined effect of mass-production training and a subsidy plan under which the Federal government paid all the cost of the actual flight training and the student paid most of the cost of his ground schooling. Approved schools were required to maintain certain standards in their training and equipment and the student had to meet certain minimum standards—mainly in regard to his physical fitness for flying. The new training plan was distinguished from earlier plans by its ambitious scale as well as by the details of application and it was inspired by the desire to create a large reserve of flyers from which to draw for complete Army training. Considering the huge numbers involved under the plan, subsidy of primary training cost Uncle Sam much less than the previous method of having the Army give complete training to raw recruits with no previous flight instruction of any type. Furthermore, under this plan, the student was under no obligation to enlist in the Army unless he wished to do so. By the last months of 1942, a total of 600 flying schools had signed air-

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training contracts with the CAA under the plan, and over 90,000 pilots had been trained.

### *Battleships versus Airplanes Again.*

As the Second World War extended in scope and intensity, it soon became evident that the "extravagant" claims of aviation enthusiasts were distinctly less visionary than they had seemed a few short years earlier. The seemingly wild promises of Brigadier General William Mitchell and Rear Admiral Bradley Fiske became stark realities that appeared—with dramatic suddenness—in the headlines of the daily press. In May of 1941, the 35,000-ton superdreadnaught *Bismarck*, pride of Germany's reconstructed navy and one of the most formidable warships afloat, was crippled by airplane torpedo hits to such an extent that she finally was sunk by surface craft. In December of 1941, the brand new 35,000-ton British battleship *Prince of Wales* and the 32,000-ton British cruiser *Repulse* were sunk by Japanese airplanes off Malay Peninsula. In its "sneak attack" upon Pearl Harbor, the Japanese Air Force sank two United States battleships and put most of the American Pacific Fleet out of commission for some time. Following this, the 29,000-ton Japanese battleship *Haruna* was sunk by U.S. Navy airplanes. Certainly, this latest war brought a conclusive answer to the question of airplanes sinking battleships! On the other hand, aerial assault upon highly fortified areas has not always produced the results that were

## THE SECOND WORLD WAR

promised. Outstanding examples appeared in the length of time that the Corregidor fortress withstood Japanese attacks and in the complete failure of *several thousand air raids* to force surrender of the little island of Malta in the Mediterranean.

### *The "Battle of Britain."*

The aerial attacks upon Warsaw, which occurred in the opening days of the war, proved a prelude to many attacks that were made by each side upon other cities later. In May of 1940, the city of Rotterdam was subjected to an aerial bombardment of the most savage and unwarranted nature, resulting in extensive destruction and heavy loss of life by civilians, including men, women and children. The barbarous nature of this attack was glaringly spotlighted by news that the city had surrendered a few hours *before* the attack. Some time later, Germany "explained" this as having been due to her inability to notify her air force in time to call off the planned attack. Despite the possibility that this might be true, there are many throughout the world who still believe that the Germans used Rotterdam as a cold-blooded "example" in the hope that it might inspire a British compromise to save London from a similar fate. If this had been the plan, Hitler greatly erred in his understanding of the British temper. No compromise being in sight after several weeks of delay, his air force began its attacks upon British cities in July of 1940. With each passing day they increased in sever-

## THE STORY OF FLYING

ity, more and more airplanes being used until as many as a thousand figured in one raid on the city of London. From the German viewpoint, at least, the results were not as expected. The raids brought heavy loss of life among civilians—men, women and children—as well as tremendous property damage. But each succeeding raid served mainly to enrage and unite a people which, up to that time, had not been entirely unanimous on the subject of war with Germany. A cry for revenge arose that brought reprisal raids on German cities; defense methods were improved; a detector operating on the principle of the radio reflection altimeter was perfected, and the Germans began to find the raids a very costly experiment. Increasing the number of airplanes in each raid only brought still heavier losses until these reached staggering proportions. It was not uncommon for several hundred airplanes to be sent over London only to have a fifth or more of them brought down—a proportion that required complete replacement of the men and airplanes in less than a week if the raids were to be sustained. Day raids gave way to night raids, but the high loss ratios continued. After this had continued for some time, the attacks diminished until they became sporadic forays conducted by a few airplanes.

### *The 1940 "Invasion" of England.*

While these aerial attacks upon Britain were proceeding, Royal Air Force reconnaissance brought in

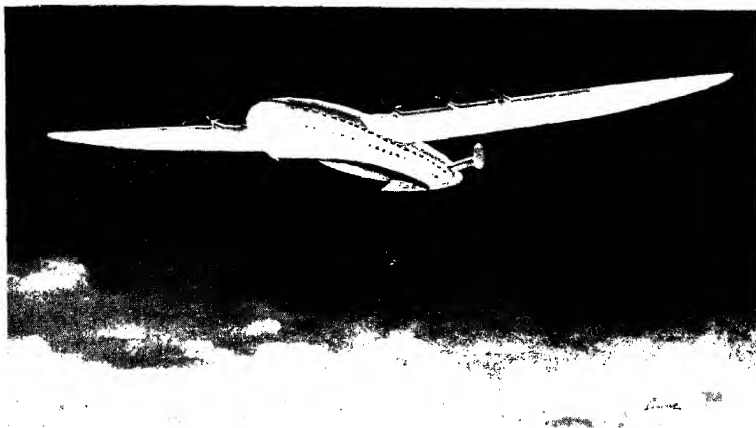


FIG. 63.—As an artist pictures the 100-passenger ultrastreamlined flying boat proposed by Sikorsky for Pan American's ocean routes. (*Courtesy of United Aircraft Corporation.*)

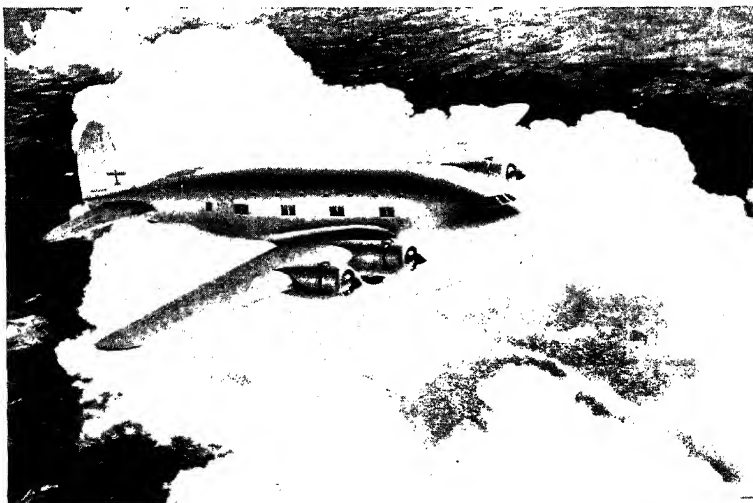


FIG. 64.—The Boeing thirty-three-passenger Stratoliner is designed for high-altitude operation and the air in its cabin can be maintained at comfortable pressure despite the rarefied atmosphere through which it flies.

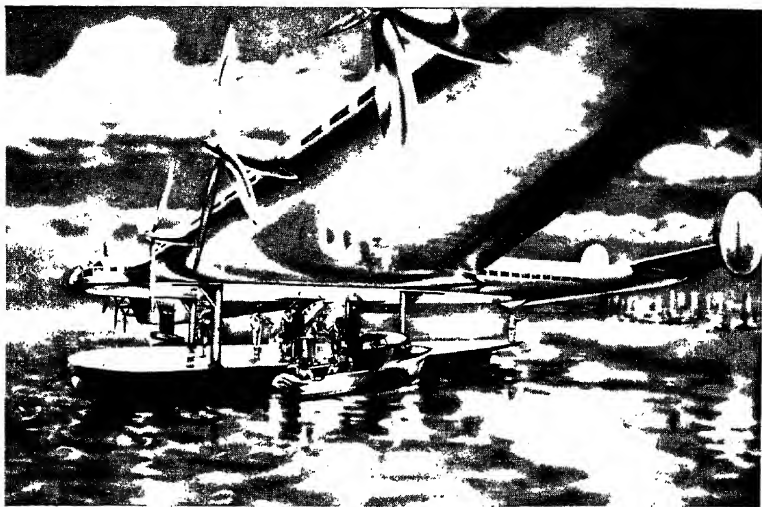


FIG. 65.—A close-up sketch of the 300-passenger, 400,000-pound flying boat that engineers of the Consolidated Aircraft Corporation found to be an engineering possibility of the future.

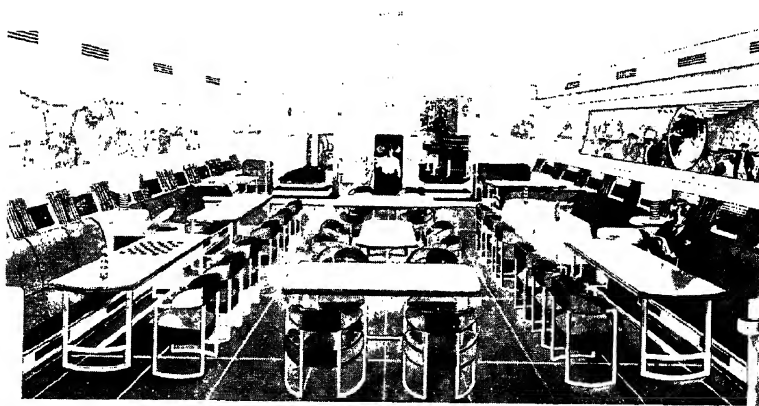


FIG. 66.—Dining saloon of a 100-passenger flying boat proposed by Sikorsky for Pan American's ocean routes. (*Courtesy of United Aircraft Corporation.*)

## THE SECOND WORLD WAR

reports of concentrations of innumerable barges, small boats and vessels of every conceivable type in the channel ports that were under German control. Apparently, preparations were being made for an attempted invasion of England, and the attacks upon British cities were part of a plan to decrease the resistance of the people. On September 11, 1940, Winston Churchill warned the British that "a heavy, full-scale invasion . . . may be launched any time now." Almost immediately following this the British Air Forces made several devastating attacks upon the barge and boat concentrations, leaving hundreds or thousands of boats and barges ablaze and sinking with their loads of German troops—right in the middle of what had all the appearance of having been intended as a "full-dress rehearsal" if not actually the invasion itself. This new disaster, piled upon the top of the heavy price that Germany paid for her London raids, apparently inspired a change in plans. Her Royal Air Force had saved Great Britain; the "invasion" never came. By 1941 and 1942 British air power was increasing and that of Germany declining. As a result there came reprisal raids upon German and Italian cities, carried out on a scale far beyond that of the worst raids on London. Also in 1942, came the famous air raid on Tokyo where the long arm of the U.S. Air Forces reached across miles of ocean to make one payment on a debt due.

## Chapter XXIII

# Aircraft of Tomorrow

### *As to Engines.*

EVER since the Wrights made their first flights with a gasoline engine, this type of engine has reigned supreme in all kinds of flying. Although development was attempted, the steam engine never became a real contender. Indeed, the Diesel has been the only other kind of engine even to question supremacy of the internal-combustion type. The Diesel was invented in Germany by Rudolf Diesel more than 50 years ago and it has since come into very general use in marine work and in the construction of stationary engines. Of late, it has also been used in the construction of tractors, motor trucks and busses, fields in which it seems to be giving a good account of itself. The Diesel does not use spark ignition. Instead, it compresses air to such a high degree that fuel oil injected into the cylinder at this point is ignited by the heat resulting from this high compression. This is why it is called a compression-ignition engine. Although theoretically simpler, the inherently heavier construction, its necessary compressors and the fuel-injection equipment actually make the Diesel more

complicated and heavier than the spark-ignition engine. On the other hand, the fuel efficiency of the Diesel is substantially higher than that of the spark type and this circumstance tends to compensate for its higher weight. In earlier days of aviation, when gasoline engines showed a thermal efficiency of only about twenty-five per cent or less, the Diesel offered much promise, since its efficiency ranged up to more than forty per cent; it would thus have required only about half the fuel for equal output. However, this situation has been radically modified by substantial improvement in the efficiency of gasoline engines—accomplished mainly through the use of higher compression that was made possible by the invention of antiknock fuels. Some of the latest types of gasoline aviation engine have been so much improved that their efficiency is beginning to approach that of the Diesel and this has become a contributing factor in limiting the possibilities of Diesel engines in flying. In the meantime, a considerable amount of work had been put into the development of an aviation Diesel, mainly in Germany, where it was originally invented and where the higher cost of gasoline gave more incentive than existed in the United States.

#### *Diesel-engine Experience.*

The Germans, however, were not alone in attempting to perfect an aviation Diesel, nor, for that matter,

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were they the first to fly with this type of engine. For several years after the First World War the Packard Motor Car Company spent a considerable sum of money in developing an aviation Diesel and first flights were made in September, 1928. The Packard Diesel thus was the first engine of its type to fly an airplane. Extensive flying followed and the work would undoubtedly have been carried further had it not been terminated by the death of L. M. Woolson, the engineer under whose direction it was being carried on. As mentioned earlier, Deutsche Lufthansa acquired some Junkers Diesel-equipped airplanes several years ago; in consequence it acquired more actual flying experience with this type of engine than has been attained anywhere else. It is significant that Lufthansa was not entirely satisfied with the results originally attained with these engines and was replacing some with spark-ignition types when its operations were interrupted by the Second World War. Diesel troubles start with the added complication of the engine, which increases both the weight and the initial cost. The same complication has also been found to increase the cost of maintenance greatly. This proved more than enough to offset the fuel economy. Local overheating troubles also have arisen to rob it of some of its supposedly greater reliability.

Regardless of the type of ignition, former limits of engine-cylinder size—imposed by cooling problems—

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have been steadily pushed upward and new large engines may have still larger cylinders. We now have both air-cooled and liquid-cooled gasoline engines of more than 2,500 horsepower; those of still greater power are on the way. Both air-cooled and liquid-cooled engines are still in use and this situation is likely to continue, with liquid cooling being favored for the largest engines.

### *Substratosphere Flying.*

The stratosphere, which has been referred to as the superhighway of the air, is that region of the atmosphere (extending up from about 35,000 feet) where the temperature remains nearly constant instead of decreasing with further climb, as it does at altitudes below this level. It is a region free from the heavy clouds, gusty winds and other atmospheric disturbances such as exist at lower levels. Although high winds exist at this height, they are regular and the temperature varies little from winter to summer. At such high altitudes, the greatly reduced density of the air causes corresponding reduction in the resistance of airplanes. Providing that supercharged engines and suitable propellers are used, it is thus possible to fly at speeds greater than are attainable nearer the earth. (Without these, the speed would become *less* instead of greater as the altitude is increased.) Although there is a limit beyond which this cannot be carried, commercial transport air-

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planes have been built for flying at 20,000 to 25,000 feet in order to gain some of the advantages of approaching the stratosphere levels. This operation has one drawback. Because of the rarefied air, humans cannot breathe normally at altitudes above 15,000 to 20,000 feet, the critical height varying somewhat according to the individual and the amount of energy that he is exerting. Hence pilots use oxygen equipment to help their breathing when flying at high altitudes and the high-altitude airplanes now being constructed have reinforced cabins that can be maintained at pressures that are still in the comfort range, although distinctly lower than sea-level pressure.

The first airplane of this type was the Junkers, mentioned some time earlier; the first American-built was the Boeing Stratoliner, a four-engine transport, first constructed in 1938-1939. This Boeing was also the first substratosphere airplane to go into commercial use, several having been put into service by TWA shortly before the United States became involved in the Second World War. This plane is designed to carry thirty-three passengers by day or twenty-five (in berths) at night and is designed for operation at altitudes up to 20,000 feet. Fresh air is drawn in through the leading edge of the wing, compressed by blowers connected with the engines, heated and then fed into the cabin as required. At 14,700 feet the interior of the cabin can be maintained at a pressure equal to that nor-

mally encountered at 8,000 feet. For the purpose of developing equipment for supplying oxygen and for testing the reactions of pilots and passengers while they are flying at such high altitudes, use is being made of "altitude chambers," which are merely tanks from which the air can be partly exhausted. United Air Lines, for example, has done a considerable amount of research with a chamber of this type. By this means it is possible to subject the pilot or passenger to the conditions found at 20,000 or 30,000 feet, without the necessity of leaving the floor of the hangar.

*Even Rivet Heads Count at High Speed.*

The increase in airplane speed that came within recent years brought some very surprising results. It was found, for example, that even the heads of small rivets (such as are used in metal wings) offer enough resistance to have an appreciable effect upon the speed. Some laboratory investigations showed that projecting rivet heads in the wings require an increase in the engine horsepower that runs up to as much as six per cent for speeds of 250 miles an hour. Even the degree of finish of the metal-wing surfacing has an effect that is noticeable. Hence the high-speed airplanes of today already have flush rivets and would also have highly polished metal surfaces were it not for the military necessity of using a low-visibility finish. Every one of the few remaining

projections will eventually be sunk completely into the wings. Landing gears will be not only retracted but will be designed to fold completely inside of the wings or fuselage, leaving exposed only a perfectly smooth surface completely enclosing the gap through which they were drawn in folding. This is already true of the fastest military types. It is already generally agreed that engines of the larger airplanes should be housed completely inside the wings. As to construction materials, one fairly recent innovation is the use of stainless steel for wing structures and other parts. This material was first applied to wing construction by the E. G. Budd Company of Philadelphia and by Fleetwings, Inc., of Bristol, Pennsylvania. Stainless steel has many advantages in wing construction. Although distinctly heavier than the aluminum alloys now used, it has correspondingly higher strength to offset this disadvantage. Its chief distinction lies in almost complete absence of corrosion—no other metallic material in general use is so universally noncorrosive as is stainless steel. Hence it offers an important advantage, for it eliminates the possibility of reduced structural strength in airplanes exposed to salt air—a combination that works havoc with sheet-aluminum alloys unless precautions are taken to protect them. The first all-stainless-steel airplane was built in 1931 and remained in excellent condition after several years of exposure to all kinds of weather. Present indications are that much more

general use will be made of this promising material when restrictions on its use are lifted after the war.

## *New Big Airplanes.*

After a short lapse in the construction of very large airplanes, designs comparable with the huge DOX began to appear shortly before the start of the Second World War. First of these was the big 88,000-pound, seventy-four-passenger, flying boat built by Boeing for Pan American's Atlantic service. From tip to tip of its great wings it measured 152 feet; its over-all length was 106 feet; its height, 27½ feet. It was the first airplane built with two full decks one above the other, thus making a stairway connection necessary. This big clipper ship had eighteen separate rooms within the hull without counting the four engine rooms out in its wings. These engine rooms, incidentally, were reached by passageways through the wings in order to make the engines accessible in flight. The boat had a normal range of 4,000 miles, carrying forty passengers and a crew of eight. On shorter trips, where sleeping accommodations were not required, it could carry and seat seventy-four in comfort. The maximum speed was 200 miles an hour. Furnishings for the comfort of the crew and passengers alone weighed 7,200 pounds—yet it was not many years earlier that few *complete airplanes* weighed that much. Even the dining saloon accommodated fourteen persons at a

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time. A most instructive side light on the construction of this big Boeing was the fact that production was started on five others before the first had been flight tested, a circumstance that showed clearly how far engineers have advanced since the days of "cut-and-try" methods, when every design had to be developed on the flying field instead of in the drafting room. Flight testing, of course, still remains a necessity, but it now serves mainly as a check upon the work of the designer. The research is done beforehand in the wind tunnel.

### *Still Bigger Ones to Come.*

Still larger commercial airplanes and flying boats were under way before the Second World War began, and this development is certain to continue after the war ends. Blohm & Voss, the German firm, was reported as building a 100,000-pound transatlantic flying boat and the Russian government at about the same time was reported as having completed a sixty-four-passenger land airplane of the same gross weight. In France, Latecoere was also reported as having under construction a tremendous flying boat for transatlantic use that was to weigh about 145,000 pounds loaded. At the New York World's Fair of 1939, Air France Transatlantique showed a model of a 132,000-pound flying boat—with the statement that it had two such craft then under construction. Pan American Airways, on December 9, 1937, invited

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preliminary proposals from eight large builders of aircraft. These proposals were to cover the design and, if accepted, the construction of a group of flying boats for transoceanic service that were to have capacity to carry a pay load of 25,000 pounds, be able to cruise 5,000 miles at 200 miles per hour and have stateroom accommodations for "at least 100 passengers." Four firms, Douglas, Sikorsky, Consolidated and Boeing, submitted bids on airplanes of this type. Glenn Martin has already produced the "Mars," a 140,000-pound-gross-weight flying boat, and Douglas has built a 160,000-pound, 212-foot-span military landplane. As airplanes grow in size, their development costs grow also, somewhat in proportion, so that the field of large-scale airplanes will be confined in future to the few largest companies. No small firm could ever hope to complete the development of these large types. Even the Douglas DC-4, a 54,000-pound landplane, is reported to have cost between \$1,500,000 and \$2,000,000 for engineering and construction of the one of this type built.

### *A Vision of the Future.*

When bigger airplanes were first built, design engineers began to investigate the possible restrictions that might affect size and they arrived at some more or less definite conclusions—based upon the assumption that no radical structural improvement would be attained with growth. This assumption,

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never considered final, has long since been found wholly unwarranted; and the last two decades have seen our conceptions of size limits drastically revised. For it happened that each increase in size brought some refinement in structure that could scarcely have been foreseen. Greater size allowed designers to take advantage of very thick wings with high lift value, thus avoiding excessive wing area. It now seems as if airplane designers might have to revise their ideas of size limits about every decade or so. For it is not much more than fifteen years since engineers were willing to put down figures like 50,000 pounds as the practical limit of airplane size. Yet this size was exceeded several years ago and types now under construction run up to more than 160,000 pounds. In an effort to look ahead, the engineers of Consolidated Aircraft Corporation made an investigation of possible size limits in the light of aerodynamic and structural improvement up to 1938. The results were quite surprising, even to those in the business. For it was found thoroughly feasible, even with present knowledge and experience as a guide, to construct an airplane weighing as much as 400,000 pounds gross. This tremendous craft would have a span of 272 feet, length of 144 feet and its wing surfaces would total 8,400 square feet. It would require engines totaling 12,000 horsepower and both these and the passenger cabins would be completely inside its extra-thick wings—making the craft virtu-

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ally a "flying wing." It would carry as many as 300 passengers, requiring a crew of about 30, and would have a cruising range of about 5,000 miles at 300 miles an hour! Although no such craft has been constructed nor is one in immediate prospect, the report is of interest because it represents the result of careful study by a staff of engineers with extensive experience in designing large airplanes. To make the figures even more authoritative, perhaps we should say that this particular group has had at least as much experience with large airplanes as any other in the world. So this—as yet theoretical—airplane may be taken as indicative of the size of craft that the none-too-far-distant future may bring.



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